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GEOGRAPHICAL
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The Men behind Modern Geography

VII. Mackinder and the Revival of Geography in Britain

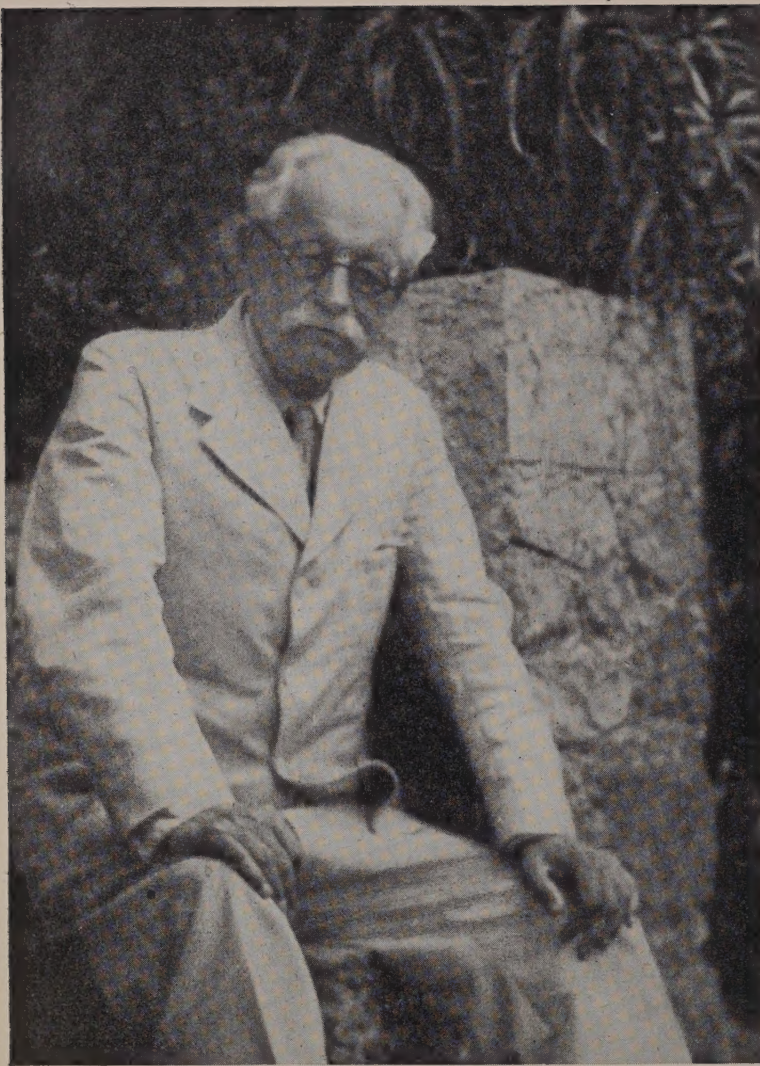
by G. R. CRONE

From the 18th, through the 19th and into the 20th century Mr Crone, who is Librarian of the Royal Geographical Society, has surveyed the evolution of modern geographical thought in the minds and lives of the men who chiefly gave it shape. The last figure in his survey has been called "the father of modern British geography" and, as the present article shows, exerted an influence which, while bringing new life to the academic world, extended far beyond it and is still active today

In an earlier article, the progress of geography in Britain has been traced down to the death of Sir Roderick Murchison in 1870. It had yet to be established as a subject of study in the universities, and in the schools it was little more than an exercise in memorizing names and miscellaneous data. Physical geography was developing fairly rapidly, but mainly under the control of the geologists. The journeys of Livingstone in southern and central Africa had however aroused great interest in exploration, and Murchison had turned this to the advantage of the Royal Geographical Society. Some opposition to the concentration of interest and effort on exploration alone had made itself felt before Murchison's death, and in the next two decades various attempts were made to enlarge the content of geography, as had been done abroad, and to improve geographical education. Markham (afterwards Sir Clements Markham), who was Honorary Secretary of the Royal Geographical Society for a quarter of a century, while supporting the 'practical' traveller against the scholastic theorists, was alive to the advantage of winning popular support by the spread of a sound interest in geography; he founded and ran from 1872 to 1878 a periodical with a broad appeal at first called *Ocean Highways* and later the *Geographical Magazine*. In 1879, he succeeded in persuading the Society to enliven its periodical publication by issuing a new series of monthly Proceedings, which embodied several features commonly found in magazines. The Society at the same time bought up his private venture. Markham's colleague as Honorary Secretary was Francis

Galton, who had travelled in South Africa. At his instigation, the Society instituted annual examinations in geography for schools and awarded medals to the winners. These examinations continued for sixteen years (1869-85), but did not produce results commensurate with the outlay, as the medals were won by a few schools with specially coached pupils. Meanwhile Douglas Freshfield, an accomplished mountaineer who wished to see geography seriously taught at the Universities so that travellers capable of producing works of scientific value might be turned out, had become an Honorary Secretary in 1881. It was he who induced the Society to discontinue the school prizes, and to undertake an enquiry into all geographical teaching. As a preliminary, John Scott Keltie was appointed the Society's "Inspector of Education", and despatched on a "voyage of discovery among the educational institutions of Europe". Keltie's report on geographical education on the Continent was published in 1885, and the teaching appliances which he brought back were placed on exhibition.

Freshfield was also engaged in negotiations with the Universities of Oxford and Cambridge, for Keltie had recommended the establishment of a readership or a chair of geography if the right man could be found. At this moment the man who was to be accepted as the founder of modern British geography was about to make his entrance. Galton had heard of a University Extension lecturer who was delivering a series of lectures on the "New Geography", and suggested that he should be invited to set down exactly what he meant by this phrase. This



Mrs E. F. Mackinder

Sir Halford Mackinder (1861-1947), who redefined the purposes and relaid the foundations of geography in Britain: taken in Capri when he was seventy-seven

from mixing up "theories with theodolites". Mackinder elaborated on the virtues of a discipline which encouraged the student to examine the causal relations of physical features, to penetrate beneath superficial similarities, and to suggest new relationships. He provided two slightly different definitions of geography, "the science whose main function is to trace the interaction of man in society and as much of his environment as varies locally", and "the science of distribution, the science, that is, which traces the arrangement of things in general on the earth's surface". It was the first of these themes that Mackinder developed, claiming that "no rational political geography" can exist which is not built upon and subsequent to physical geography. The relationship was not, however, immutable: "man alters his environment, and the action of that

environment on his posterity is changed in consequence". In illustration of his thesis, he dealt briefly with south-eastern England and the sub-continent of India.

Though Mackinder's arguments would have been commonplace to contemporary German geographers, they had never been stated so forcefully and directly in England before. He appears to have been surprised at the general unanimity with which they were received. Among those who commented upon it was J. A. (afterwards Lord) Bryce, who had shortly before addressed the Society on historical geography: he commended geography as a philosophical training, inculcating the habit of observation and the principle of causality.

The upshot of all this was the establishment by the University of Oxford of a readership in geography, for which half the stipend was

innovator was a young Oxford graduate, Halford John Mackinder, who had shown an aptitude for geography from his early years, and who had equipped himself with a sound scientific training. Mackinder was invited to address the Society on his chosen theme. His lecture, "The Scope and Methods of Geography", which Markham considered might mark "an era in the history of our Society", was delivered in February 1887. Greatly daring, Mackinder designed his paper as a confutation of the views advanced in an address to the British Association the previous year by Sir Frederick Goldsmid, who had separated historical from 'scientific' geography. After Mackinder's paper, Goldsmid suggested that a child was endowed either with mathematical or with classical capacity, and that little could be expected

provided by the Royal Geographical Society, and the appointment of Mackinder to the post at the age of twenty-six.

His lectures in time attracted large audiences, especially those on historical geography; and this aspect came to occupy much of his attention. In his Presidential address to Section E Geography of the British Association at Ipswich in 1895 he borrowed the term 'anthropogeography' from Ratzel, and asserted that "the anthropogeographer is in some sense the most typical and complete of geographers". He uses also the term 'human geography', but makes no reference to the French school. The address illustrates the dominant part German geographers played in his development.

It had now become obvious that no real advance would be made in geography unless provision was made for the systematic training of teachers, and Mackinder proposed in this address the foundation of an institute in London under the direction of the Royal Geographical Society. Finally however with the Society's support, a School of Geography was established in Oxford in 1899 and a diploma instituted. To round off his qualifications, Mackinder, just prior to the opening of the School, made an expedition to East Africa and achieved the first ascent of Mount Kenya—for in the popular view a geographer must also be "an adventurer and explorer"! The full result of Mackinder's study of historical geography was seen in his *Britain and the British Seas*, published in 1902, a work long recognized as a classic of British geography. It contains a masterly summary of the fundamentals of British geography, based on wide reading and much thought, followed by a review of British history in relation to this background. But another essay in historical geography was to bring Mackinder unexpected fame, and a connection by no means altogether agreeable to him. In January 1904, he read a paper to the Royal Geographical Society with the innocent title of "The Geographical Pivot of History". The main points he made, summarized briefly, were: (1) The maritime age has passed, and no major area of the land surface remains to be explored. (2) In the future, land-power will be decisive, and since the world is now a closed system, the clash of great powers will have world-wide repercussions. (3) The greatest land area is in the Old World, and at the heart of this lies a vast area with Continental or Arctic drainage (thus entirely beyond the reach of sea-power) and on the whole a land of steppe or desert. This has been the

home of horse- or camel-riding nomads, whose raids upon the settled lands of the periphery have recurred throughout history. (4) The character of this area is now changing radically: trans-continental railways and the progress of colonization are creating here a basis of power, and this power, by virtue of holding interior lines, occupies the central strategic position in the world. (5) Outside the "Heartland" is an inner crescent of marginal continental states and beyond that an outer crescent of overseas powers including Britain, the United States, and Japan. (6) "The over-setting of the balance of power in favour of the pivot state, resulting in its expansion over the marginal lands of Euro-Asia, would permit of the use of vast continental resources for fleet-building, and the empire of the world would then be in sight. This might happen if Germany were to ally herself with Russia." (7) Against this threat, the overseas powers should maintain bridgeheads in "France, Italy, Egypt, India, and Korea", which would oblige the "pivot allies" to develop their land forces and thus prevent them from concentrating upon the maintenance of powerful fleets.

Mackinder's paper produced a long and generally approving discussion. Perhaps the most interesting comment came from Mr L. S. Amery, who suggested that if the aeroplane was developed as a means of communication "a great deal of this geographical distribution must lose its importance, and the successful powers will be those who have the greatest industrial basis". Mackinder had pointed out that political power is the product not only of geographical conditions, but of the "relative number, virility, equipment, and organization" of the rival nations, but he did not pursue this far in relation to the Heartland. The paper appears to have been forgotten for a number of years, until Mackinder elaborated the theme in his *Democratic Ideals and Reality*, published at the close of the First World War. He saw the origin of that war as an attempt by Prussia to use the Heartland as an instrument of world dominion. Since land-power had been able to deny the Baltic and Black Seas to the Allied Navies, he extended his Heartland to include Eastern Europe. He thus sums up his fully developed theory:

Who rules East Europe commands the Heartland;
Who rules the Heartland commands the World Island;
Who rules the World Island commands the World.



By courtesy of the Royal Geographical Society

He urged that the issue between German and Slav in East Europe must be finally decided by the creation of "a tier of independent states"; with the end of this rivalry he thought Germany and Russia would each tend to fall into a loose federation of states. He also advocated the internationalization of Palestine, Syria and Mesopotamia, the Bosphorus, Dardanelles and Baltic outlets, and the protection of Indians and Chinese from conquest by the Heartland.

Even in this expanded version, the theory attracted little attention, until it was adopted by General Haushofer and the German geopoliticians. 'Geopolitics' was evolved by the Swede, R. Kjellén, during World War I, but it did not make much headway until it was adopted by the Germans. It was, in fact, a development of the theories of Friedrich Ratzel, who was acknowledged by Haushofer as its true founder—the critical point being Ratzel's transfer of Comte's and Herbert Spencer's sociological theories to political geography. The mainspring of geopolitics was Ratzel's conceptions of space, position and movement. Kjellén regarded the state as a biological organism, requiring a definite area for its subsistence, struggling with competing organisms, and waxing and waning according to its inherent vigour. It was therefore capable of being studied as biologists studied other organisms, i.e. as a pheno-

menon whose history and distribution in space could be explained on geographical grounds. Haushofer took over the general ideas and terminology of Kjellén, and developed geopolitics as the application of geography to politics, replacing the 'static' outlook of political geography by the 'dynamic' art of geopolitics. The practical outcome was the use of 'geographical' arguments to sustain and advance Nazi power-politics under a pseudo-scientific guise: for example, as a vigorous state developed, it had to acquire additional territory and especially areas which threatened it strategically: a state which ceased to be aware of its space relations—that is, shirked this task—was a state in decay. Finally, under pressure from politicians and journalists, Haushofer was obliged to abandon the scientific outlook which he had at first striven to maintain, and geopolitics degenerated into mere propaganda.

From 1925, Haushofer was aware of Mackinder's Heartland hypothesis, and it had immediately seized his imagination—"the greatest of all geographical world views" he acclaimed it. He was the advocate of a German-Japanese alliance, which, with or without Russian cooperation, he hoped would ultimately dominate the World Island.

It was perhaps natural that on the conclusion of the Nazi-Soviet pact in 1939, American journalists, with some knowledge of



Not the least notable instance of Mackinder's genius was his highly original skill in presenting broad geographical concepts by means of simple sketch-maps or diagrams. Most of these are too closely linked with their respective contexts for separate reproduction; but three examples of them are given here. (Opposite) The world-map which illustrated his lecture on "The Geographical Pivot of History" in 1904

(Above) An illustration from *Democratic Ideals and Reality* showing the boundary of the Heartland (broken line) extended beyond the "regions of Arctic and Continental drainage" to include the "lofty plateau courses of the Pacific and Indian rivers". The Great Lowland provides an "open passage from the Heartland into Europe".

(Right) The World Island, "divided into six natural regions", two of which—the European and Monsoon Coastlands—contain three-quarters of the world's people, or four-fifths of the population of the World Island, though they together measure scarcely one-fifth of its area



Both maps reproduced from Sir Halford Mackinder's "Democratic Ideals and Reality", by courtesy of Mrs E. F. Mackinder and Messrs. Constable & Co., Ltd.

Haushofer's use of Mackinder's theory, should jump to the conclusion that the pact was inspired by Haushofer and thus indirectly by Mackinder. The pact however was based on other considerations, and Haushofer's influence with the Nazi leaders was exaggerated. The interest aroused led to the republication of *Democratic Ideals and Reality* both in America and in this country, and to a prolonged discussion of the basis of geopolitics. Mackinder commented further on his generalizations in 1942, but could only advise the allied powers to strive to retain control of the bridgeheads. Fortunately, his theory was never fully put to the test. After this unlooked-for notoriety, Mackinder's concept has undergone a certain amount of criticism. It is not possible to examine the whole question in detail here, but some reflections on its relationships and its present status may be advanced. It was undoubtedly a product of its time, i.e. the opening years of the 20th century. Its space ideas owe a good deal to Ritter and Ratzel; the completion of the trans-Siberian railway and the imminent outbreak of the Russo-Japanese war appeared to challenge the then popular 'command of the seas' theories of Admiral Mahan and his school; industrial development was reinforcing the argument that, granting Mahan's thesis, only a large and productive national territory could maintain a sufficiently powerful navy. There is also the *fin-de-siècle* feeling that an age had closed and that there were no more frontiers. Without being wise after the event, one may point to two considerations which modify the Heartland thesis as originally presented. In the first place, Mackinder seems to have been ill-advised in the world map he used to illustrate it. It appears to be a Mercator outline disguised, whether deliberately or not, in an oval frame. The effect is to hide the true relationship of Northern Asia and North America, thus emphasizing the isolation of the latter, and also to exaggerate the northern areas in relation to the equatorial regions. Exponents of the 'new geography' point out that the great circle routes from North America to Asia pass over the polar basin; as these are unlikely to be utilized effectively for air routes, at least in the near future, this relationship should not be over-emphasized, but, at the same time, it tells against the inviolability of the World Island.

Another criticism is founded on an evaluation of the industrial potentialities of the Heartland. Though he was aware of the importance of this factor, he does not seem to have examined it in detail. Railway com-

munications, for example, have not been developed to the extent that he appears to have anticipated. Technological progress, industrial equipment, and resources of trained manpower do not, at present at least, favour the Heartland. The advantage of "interior lines", however, remains, even if the possibilities it presents have yet to be fully developed.

This digression on geopolitics has wandered rather far from the development of British geography.

By 1905, when he left Oxford, Mackinder had made his main contribution to geography: his later achievements were in the fields of university administration and public affairs. To geography he had brought the power of eloquent exposition and a gift for brilliant generalization backed by energy and singleness of purpose. His influence is still strong, and his ideas are being developed by a new generation of geographers. At Oxford he was succeeded by A. J. Herbertson who, having studied at Montpellier, was influenced by the French school, and also to a considerable degree by his friend Patrick Geddes, the sociologist. Herbertson worked hard to improve the standard of geographical education in this country, but he is probably best remembered for his development of the concept of natural regions, first outlined in a paper to the Royal Geographical Society in 1904. Abandoning political divisions, he substituted for them units based on configuration modified by climate and vegetation. These he sought to establish as "definite associations of inorganic and living matter, with definite structures and functions, with as real a form and possessing as regular and orderly changes as those of plants or animals". Natural regions however are relative, not absolute; researchers delimit regions to suit their particular purposes. In this way the regional technique has been fruitful and is still fundamental, although Herbertson's attempt to systematize geography on the lines of botany or zoology was a failure.

A reference, however brief, should also be made here to Markham's achievement in reviving Antarctic exploration at the close of the last century and to his establishment of a Research Department at the Royal Geographical Society for the discussion of geographical subjects of a technical or academic character. We may note, too, the fulfilment of his ideas on the Society's publications with the appearance of the *Geographical Journal* in 1893. Markham and Mackinder, in their different ways, set British geography on its 20th-century course.

The Background of Siamese Dancing

by MAURICE COLLIS



In South-East Asia, between the coastlands of India and China, lies a group of countries of whose ancient culture Mr Collis has written with delightful scholarship, as in Siamese White, She Was a Queen and The Grand Peregrination. He here relates the Siamese dance to this cultural background

"BUT they are not yet numbered, the dances of the East", wrote the Japanese poet Hagoromo. Indeed, we have hardly yet begun to count them. In aggregate they amount to so vast and complex a phenomenon that it may take a century's research to relate them to each other. Bound up with Asia's religions, arts and history, they have a development that varies with the territories in which they are practised. To trace their history would be to describe the culture of a dozen countries. When therefore the question is asked—what is Indian dancing or Siamese or Javanese?—only the most general answer can be given. Nevertheless, it is possible to provide certain clues.

The first point to get clear is that the dance in the huge region between India and China, which includes such countries as Burma, Siam, Java, Bali and Indo-China, is founded on Indian classical dancing. The differences between the dance of, say, Burma and Siam or Indo-China and Bali are variations on a common heritage. The average European, if shown in succession typical dances from these countries, would be quite at a loss to put into words the distinctions which he would sense rather than actually see. That they are distinct, indeed quite distinct, detailed study would quickly reveal; their differences are as much as those between the architecture, sculpture and music of the same countries, differences as great or as little as divide, say, the arts of England and France, which also have a common source in a classic antiquity.

The mother-cultures of Asia are Indian and Chinese. The culture of China might well have entered the region lying between it and

India. But in fact it was the culture of India that prevailed there, for circumstances permitted her ideas to get there first. In the early centuries of our era there occurred a long peaceful infiltration of Hindus down the coast of the Bay of Bengal into Burma and from thence into Malaya, Sumatra, Java and beyond. The emigrants brought with them the whole apparatus of Indian culture, which was every bit as complete as the Graeco-Roman, comprising as it did literature, music, painting, sculpture, architecture, two religions (Hinduism and Buddhism) and all the minor arts, including the dance. A series of splendid Hinduized kingdoms came into existence from Burma to Champa (which lay in the southern part of Indo-China) and lasted over a thousand years. Everyone knows something of Angkor, its architecture and its sculptures; but the other capitals in the region had as brilliant an art, as all who have seen examples of it in the Guimet Museum in Paris are aware.

Now, a characteristic of Hindu civilization was that the main use to which the arts were put was religious. There was far less secular art than in Europe. Even the dance was brought into line with this general usage. Though a minor art, it received great attention from Hindu thinkers, who enormously elaborated it until it became as esoteric and symbolic as the major arts. Its elaboration may be seen in the number of hand gestures and movements of the body tabulated in such Sanskrit classics as the *Bharata Natya Shastra*, where it is treated as a science. There are detailed in that work twenty-four ways of moving the head, each having its particular signification to the theme, four ways of

moving the neck, six for the eyebrows, forty-four for the eyes, and no less than fifty-seven for the hands. These fifty-seven hand gestures were further developed until they became a language capable not only of expressing emotions but of telling a story. The two main divisions of Indian dancing were (and still are) the temple style (*Bharata Natya*) and the dramatic style (*Kathakali*), the former consisting of danced invocations, the ritual of offerings, and symbolic renderings of cosmic metaphysics, the second concerned with presenting half-heroic half-divine stories, such as are found in the classical epic, the *Ramayana*. Mr Ram Gopal has given examples of both kinds in London recently.

This art was transported to all the Hinduized kingdoms and so came to Cambodia, with its capital of Angkor, whose territory comprised most of modern Siam. The walls of the great temple of Angkor Wat are covered with reliefs of dancers which, though carved about 1100 A.D. and in a country 1500 miles away from India, conform to the classical canons of Hindu dancing. This Hinduized kingdom lasted until about 1400 A.D. when it was overwhelmed by the present Siamese.

What was the attitude of the Siamese to the Indian art of the dance which they found established in Cambodia? The answer will give us a clue to the nature of Siamese dancing as it exists today, but unfortunately it is very difficult to formulate. In the first place one has to remember that the Siamese (or Thai as they are more properly called) had not been Hinduized. Nevertheless—and it is here that the matter becomes so complicated—their culture was Indian. As I have pointed out, there were only the two Asian mother-cultures, the Chinese and the Indian. The Thai came from Yunnan, a border state of China. One might be pardoned for supposing their culture to have been Chinese. In fact, they had a tincture of Chinese culture. But on their way down from Yunnan to Cambodia, a slow migration which took centuries to accomplish, they were brought in touch through Burma with the Buddhism of Ceylon, which was then enjoying in Burma a remarkable vogue. Buddhism also existed in Cambodia, but it was a different variety and was mingled with the worship of the Indian classical divinities, particularly Shiva. While the Cambodians had achieved some sort of a synthesis between Hinduism and their variety of Buddhism, called the *Mahayana*, the Ceylon type of Buddhism, known as the *Hinayana*, which the Siamese conformed to, was of too strict and narrow a nature to allow of any such synthesis. It

follows that the Siamese, though confronted in Cambodia with a civilization which was grander than their own, strongly disapproved of some of its elements. Their own art, like their religion, was inspired by what they had seen as they passed by Burma, and their talents were so considerable that they had been able to create a distinct style of their own, which retains a faint flavour of their original home in China.

These few facts will suffice to make clear how they were likely to react to what they found in the Cambodian empire. What they actually did was to establish their own culture in that area, at the same time taking over from Cambodian culture items which pleased them and did not run counter to their *Hinayana* principles. It stands to reason that they were bound to reject the Hindu temple dance style (*Bharata Natya*) with its dance rituals, invocations and cosmic symbolism. But their disapproval did not extend to the dances connected with dramatic legends, the Indian style known as the *Kathakali*. The Hindu epic, the *Ramayana*, delighted them, as did its sister epic, the *Mahabharata*, and they admired them for the same sort of romantic reasons that we admire Homer. Broadly speaking it can be said that in taking over what interested them in the Hindu dance they dispensed with its deeper esoteric side.

As pointed out further back, the Indian dance was highly elaborated in order to fit it to carry its transcendental mood. With the elimination by the Siamese of the real inner meanings, it was not necessary to employ such an apparatus of hand, neck, eye and head movements. So, while the various gestures and poses of the Siamese dance derive from the Indian, they are far less numerous. Hence resulted a less serious, a more light-hearted dance, a dance with none of the tremendous overtones of the Hindu religion. As for the costumes, samples of which we see in the accompanying photographs, they derive from the Indian via the Cambodian, but are touched with the Siamese style, an original creation which has distant echoes of China. In conclusion, it is interesting to note that the tendency of Siamese, as of other Further Indian dancing, is towards abstraction, that is to say towards movements whose significance lies rather in design or pure choreography than in literary meaning. While the Indian dance, like the paintings of the Italian masters, is the thrilling fusion of art and literary meaning, the Siamese dance, by the elimination of meaning, tends to be a little dry and to substitute charm and elegance for vision.



Ektachrome

All photographs by Ian Mor

The traditional dances of Siam and the neighbouring countries, though distinct, have a common source in Indian classical dancing. Two Siam-ese girls in a dance depicting a legendary story of gods and goddesses

In its journey to Cambodia from India the exact and subtle art of dancing lost its original, deeply religious symbolism and with that a great many of the elaborate movements and significant gestures. It became more romantic and light-hearted, but still retained some of the legends and heroic stories that derived from the country of its origin. (Right) Akom, a famous exponent of traditional Siamese dancing, in the role of P'ra Naray who assumed the form of a beautiful girl in order to subdue a mischievous demon



Ektachrome



Ektachrome

The costume of Siamese dancers is brilliant with colour and sparkles with jewels. Ornate head-dresses, such as that worn (left) by a girl from the troupe of the Silpakorn Theatre in Bangkok, are both Siamese and classical Indian in style, and her elbow and hand are held in a manner that can be seen in early South-East Asian sculpture. Although fewer movements are used in Siam than in India (where there are fifty-seven for the hands alone) each graceful position of the fingers or even eyebrows has its meaning and can move the tender-hearted audience to tears or laughter

Orchid-Hunting in Britain

by VICTOR S. SUMMERHAYES

For over twenty-five years Mr Summerhayes has been in charge of the scientific work on Orchids at the Herbarium at Kew. His life-interest has been the study of plants in relation to their environment. The colour-plates accompanying his article are reproduced by permission of Adprint and the Editors of the New Naturalist Series, published by Collins, in which they will appear this month as illustrations to a volume by Mr Summerhayes entitled Wild Orchids of Britain

HAVE you ever gone orchid-hunting? There is no need to penetrate steaming tropical jungles or to climb precipitous mountain crags in order to enjoy this most entrancing and stimulating pursuit. You can do it right here in the woods, meadows, downs and marshes of our own islands.

Over fifty kinds of orchids inhabit the British Isles and, though they may not equal in magnificence their tropical relatives, they include some of the most charming and intriguing of our wild flowers. Very few other plants can rival the stately beauty of the Lady Orchid, sometimes as much as three feet in height, or excite more interest than the grotesque Spider Orchid and its near relatives, of which each flower seems to harbour a large fat spider, bee or other insect.

But orchids generally have to be looked for. They are rather picky plants with very definite likes and dislikes as regards where they grow, though not all are equally particular. Some kinds may be found in a variety of situations, whereas others, such as the Lady's Slipper, only grow in certain sorts of woods on a limited variety of soils. Even when the soil and other surroundings appear quite suitable, there is no certainty of finding the plant for which you seek. On the other hand, you may quite suddenly come across vast numbers of some kind of which you have previously only encountered ones and twos.

Whatever part of the country you live in, there are always some orchids for which you may seek. The southern half of England, especially the chalk hills of the Home Counties, is richest in different varieties of orchids, but there are many kinds which have their home only in the north of England, in Scotland, or even across the water in Ireland. For instance, the Spider Orchid, Lady Orchid and Man Orchid can only be found in southern or south-eastern England, the Lady's Slipper is now restricted to certain parts of Yorkshire, while the Creeping Ladies' Tresses, though occurring locally in Norfolk and the extreme north of England, may be

seen in a perfect setting only in the ancient pine forests of the Scottish Highlands.

Where does one look for orchids? You may find them in almost any sort of untouched country, but the more the interference by man, the fewer orchids you are likely to see. Heavily grazed pastures, arable fields of any kind, artificially sown meadows, all are unsuitable as homes for orchids. On the other hand chalk downs, beech woods, swamps and marshes, or the damper parts of the extensive sandhill systems around our coasts, provide happy hunting-grounds for the observant orchid-lover. Here you may, if you are lucky, find orchids literally in thousands, studding the ground with their pink, white or purple flower spikes. Nevertheless many of our orchids are among the rarest of British plants, and it is these species which provide the orchid-hunter with his greatest thrills.

These rare kinds of orchids may occur in all parts of our islands and in a great variety of situations. The Lady's Slipper, illustrated on p. 546, is one of the rarest of our orchids, since it is known with certainty to grow in only one locality, in Yorkshire, and there are very few plants even there. Several other species, such as the Military and Monkey Orchids, are found in a single place, while many occur scattered about in very small groups or as single plants.

Why are these orchids so scarce? A simple answer cannot be given to this question, since the explanation varies with the kind of orchid. For instance, the two kinds of Spider Orchids, the Lady Orchid and the Man Orchid are much commoner farther south in Europe, but the climate in the greater part of the British Isles is not suitable for them. They can flourish only in southern England on the warm soil of the chalk hills, where the conditions most closely approximate to those of their true home. The explanation of the rarity of the Lady's Slipper is quite different: this plant has been rooted out of house and home! Ever since the 17th century, when it was first recorded from Britain, it has been ruthlessly dug up and transplanted to gardens.

The Lady's Slipper, Cypripedium calceolus, is one of the rarest, as well as one of the most striking, of Britain's native orchids. It was once plentiful in West and North Yorkshire, but is now only found in one part of that county though it may survive elsewhere. Its natural habitat is in the mixed woods of ash and oak, with hazel undergrowth or scrub, which are characteristic of the rocky 'scars' or carboniferous limestone along the sides of the northern dales





Kodachrome

The charming little Early Spider Orchid, Ophrys sphegodes, used to be widely spread in southern England, but is now much less frequently met with. It is, however, very abundant in good years in those parts of Dorset, Sussex and Kent most favourable to it. It grows best in areas of short turf on the chalk downs and other limestone hills, especially near the sea. This orchid naturally prefers an equable climate similar to that of south-western Europe, its true home



Orchis purpurea

The Lady Orchid, or Great Brown-winged Orchid, *Orchis purpurea*, is in many respects the finest of our native species. Kent is the best county in which to look for it, though individual plants are still occasionally to be seen in Surrey and Sussex. It prefers open woods or scrubby places on chalky soils, but is sometimes found right out in the open. The species is in full flower towards the end of May, at the same time as the Man Orchid, a near relation

*The remarkable Man Orchid, *Aceras anthropophorum*, so named because of the resemblance of each tiny flower to a human being, is another representative orchid of southern and eastern England. It is quite abundant in some parts of the North Downs near London, where it grows among the tall grasses on the steeper slopes, and occurs less commonly in East Anglia and the limestone districts of Northamptonshire, Bedfordshire, Oxfordshire and the Somerset hills round Bath*





Ekiachrome

The Creeping Ladies' Tresses, Goodyera repens, unlike the other four orchids illustrated, is chiefly an inhabitant of Scotland. There it occurs in the old Highland pine forests, which are known from records to be the remnants of a once much more extensive forest region. The species also abounds in certain pine plantations in Norfolk, where it is thought to have been introduced with the seedling trees. The leaves of some plants are delicately veined with white

Most of the plants thus treated die, so it is definitely a practice to be condemned. Once widely spread in western and northern Yorkshire, in parts of Durham and in Westmorland and Cumberland, the Lady's Slipper is now reduced to a precarious existence in its sole Yorkshire home.

Not all our rare orchids, however, are dwindling though it is to be feared that this is true of most of them. The Lizard Orchid, one of the most bizarre members of our native flora, and for many years found only near Dartford in Kent, has during the last forty years or so increased much in numbers and turned up in many new districts. You may be lucky enough to come across it anywhere south and east of a line from Lincolnshire south-westwards to Devon. Only last year over 200 plants were seen at one locality in Kent, a truly amazing sight. Like many other orchids it grows usually on soils rich in lime, particularly the chalk, but it also shows a partiality for sandhills. It is always worth while searching bushy places on limy soils for this remarkable orchid.

The Man Orchid is another species which seems to have spread in recent years. Its favourite haunts are the steep grassy slopes of the chalk downs and hills, especially where the grass is moderate in height, though you may find it in shorter grass, as in the picture on p. 549. It has a curious habit of often growing near the bottoms of slopes, differing in this respect from most other orchids. The Man Orchid is still locally abundant in the Home Counties, especially in Kent and Surrey, but it also occurs more rarely as far north as Lincolnshire and westwards to Somerset. With the Man Orchid, though flowering a little later (June), you may find the pink spikes of the Fragrant Orchid, while still later the brighter pink spikes of the Pyramidal Orchid will be found among the nodding heads of the grasses.

In direct contrast to these species is the quaint Spider Orchid, for this rather inconspicuous plant seems to shun the taller grass and is most at home in the short downland turf. Indeed the best place to look for it is in old chalk-pits, abandoned chalk-diggings or any irregularities in the ground where the grass is short and rather sparse. Progression on hands and knees is the surest way of discovering the Spider Orchid. The brown-and-green flowers are naturally camouflaged, and easily blend into the pattern of the surrounding vegetation. The Frog Orchid, which favours similar localities and is often only an inch or so in height, is even more difficult to

find than the Spider Orchid. I have more than once trodden on the almost invisible spikes of deep green or reddish flowers, even when searching for the plants.

If there are woods in your neighbourhood, they will usually provide opportunities for searching for orchids. Many kinds are inhabitants of woods, some occurring where no other plants seem able to survive. Pre-eminent among these latter is the very rare Spurred Coral-root, which has only been discovered on about ten occasions altogether in Britain. There are no leaves, the short spike, bearing two to four large pink-and-yellow flowers, being the only visible part of the plant. It is thought that the underground stem may go on living for ten to twenty years without producing any flowers. The oak woods of Shropshire and Herefordshire or the beech woods of parts of Oxfordshire are the places to look for it, but it may turn up anywhere in similar surroundings: dark and gloomy woods with the ground covered by a carpet of rotting leaves. If you think you have found it, communicate with a reputable botanist or botanical institution; it may be an historic occasion.

There are, however, woodland orchids which are more easily found than the Spurred Coral-root, the commonest being the elegant Early Purple Orchid. This has a tuft of shining green deep purple-blotched leaves and a spike of red-purple flowers; when growing, as it often does, with the common bluebell the effect is particularly charming. The Early Purple Orchid occurs throughout the British Isles, not only in woods but also on downs, in the North Country dales, by the sides of roads or even on earth-covered walls in the south-west. An even more beautiful species is the magnificent Lady Orchid, illustrated on p. 548, but this, unfortunately, is almost restricted to Kent though it is quite common locally in that county. On the whole beech woods are richest in species of orchids, particularly the hangers or steep beech woods which are so characteristic of the escarpments of the chalk hills.

Quite different in style from these species is the delightful little Creeping Ladies' Tresses. This is a constant inhabitant of the old pine forests which occur in the Scottish Highlands in Aberdeenshire and Inverness-shire, while it is also found in much younger pine plantations. Where it is really happy it occurs in thousands, the delicate white flower-spikes and the pale green or marbled foliage producing a delightful ensemble. The plant is well adapted for life in the thick deposit of

needle leaves which always covers the ground under pine trees. The stems are thin in the lower part and more or less buried in the layer of needles and moss, the flowering branches alone growing upright. The slender creeping stems branch repeatedly, so forming a close criss-cross network and enabling the plants to obtain the maximum food from the rather poor soil. In similar places you may find the Lesser Twayblade, only a few inches high with two small heart-shaped leaves and a spike of tiny reddish flowers. Also, but much more rarely, you may come across the Common Coral-root, bearing small yellowish-white flowers and no leaves.

The orchid-hunter who is willing to brave the discomforts of marshes and bogs will often reap a very satisfying harvest. On the whole the orchids which flourish in such places are quite different from those already mentioned. As might be imagined, the so-called marsh orchids form the bulk of the orchid populations of wet places. These plants include some of the most splendid of our native orchids, possessing dense spikes, sometimes as much as a foot in length, of bright pink, rose-purple or magenta flowers. And you may see hundreds of them if you are fortunate. For those who live in southern England the Common Marsh Orchid is the most frequently met with, in damp meadows, marshes, or among reeds or rushes by streams and ponds. Reaching a height of two feet or more in favourable localities, it is among the finest of our native wild flowers, and a field containing hundreds of its rose-purple or deep pink spikes is a sight not easily forgotten. But like other orchids it is easily damaged by grazing animals. I have more than once laboriously tracked down a recorded locality of this lovely plant only to find that cattle or horses had destroyed almost every plant, either by trampling or eating the flowering stems. In the north of England, in Wales, Scotland and Northern Ireland the Common Marsh Orchid is replaced by the Dwarf Purple Orchid, a smaller plant with incredibly brilliant red-purple flowers and the leaves often finely purple-spotted. This is essentially an inhabitant of hilly districts though you will not usually find it high up on mountains where, indeed, orchids are rather scarce. Other species are found in various parts of the British Isles, the most widely spread being the Early Marsh Orchid which, as the name indicates, comes into flower earlier than the others, usually towards the end of May. This orchid is notable for the remarkable range in the colour of the flowers which may be pale straw-coloured or yellow-

ish-white, pale or darker flesh-coloured, various shades of pink up to deep madder-red and even brilliant red-purple similar to the colour in the Dwarf Purple Orchid. You may sometimes find many of these colours in plants growing quite close together, or, on the other hand, all the plants in one place may have flowers of much the same colour.

Two other orchids which are always worth looking for in swamps and similar places are the Marsh Helleborine and Marsh Fragrant Orchid. The former has a bunch of pointed much-pleated leaves, and a spike of pink-and-white nodding flowers; it creeps underground extensively rather like the lily of the valley. In some places, notably near the sea, all the plants have whitish, rather than pinkish, flowers. The Marsh Fragrant Orchid is similar to the ordinary Fragrant Orchid of our downs, but has a larger spike of very sweet-scented flowers reminiscent of clove carnations in odour.

The reader will probably have already gathered that our orchids are not all in flower at the same time. In fact there is a regular succession from late in April, when the first species open their flowers, until the end of September, though June and July are the best months taking the country as a whole. The Early Spider Orchid and Early Purple Orchid are the first to flower. These are followed closely by the delightful little purple-flowered Green-veined Orchid, a frequent inhabitant of cowslip fields in the south. A number of other species are at their best later in May, including the Lady and Man Orchids. June, however, is the real month for orchids in the south, while farther north July yields the maximum variety of species. The numbers tail off in August, but the tiny Autumn Ladies' Tresses, only an inch or so in height with small white flowers in a spirally twisted spike, is in full flower in late August and throughout September.

I hope I have been able to give you some idea of the pleasures awaiting anyone who cares to take up orchid-hunting as a spare-time hobby. But may I here enter a plea that our native orchids should not be uprooted, and only picked sparingly, as they mostly depend on seed to maintain themselves and the seedlings usually take years to reach the flowering stage. May I therefore urge orchid-hunters to take a leaf from the book of modern big-game hunters, who have substituted the camera for the gun. The colour-photographs reproduced here show what delightful pictures may be obtained. With these final words I wish you "Good luck and good hunting".

British Energy Spells Power and Plenty

I. How Energy can be Won

by PROFESSOR E. G. R. TAYLOR

Our pride in our two thousand years of history gives others the impression—often with most unfortunate practical results—that we regard Britain as a museum. Short work is made of this idea in the following, and a subsequent, article by a geographer who is concerned to demonstrate that Britain is very much alive and can remain so. To illustrate her articles and as a contribution to the Festival of Britain our readers will receive with the May number a decorative map measuring 18 by 27 inches and printed in six colours—a map-guide to local topics of conversation

A RAPTUREOUS American poetess (so the story goes) threw wide her arms one day and exclaimed: "I accept the Universe". "Egad! she'd better", commented Thomas Carlyle. And it would be better likewise if all those artists, writers, moral philosophers and the rest who turn their heads for ever backwards to lament a vanished rusticity would decide to accept modern industry and its pendant of urban growth as just—part of the Universe! For 50,000,000 people crowded on this smallish island simply cannot find a livelihood as shepherds, village handicraftsmen, hedgers and ditchers, bodgers, gamekeepers or any of the other occupations that are dear to literary fancy. And if we could imagine our specialists in taste and culture to go one step further, and from merely accepting to actually embracing modern industrialization, then very certainly their kiss would transform its hideousness as dramatically as Beauty's tenderness transformed the Beast.

Indeed, as our illustrations show, there are signs of a change. Architects, designers and engineers acting in concert have shown how a building or group of constructions precisely adapted to function, whether office, mill, bridge, engineering shop, power station or what you will, can exhibit that stability and balance, dignity and sense of purpose for which great industry at its best commands esteem. The "dark Satanic mills" of Dickens' day have long disappeared (although capacious writers keep the phrase alive) and while it is true that they have too often been replaced by structures and lay-outs of unimaginative dreariness, that is largely the result of our social attitudes. Industry was treated as an outcast, and grew up ugly because it was expected to be ugly. Already when Dickens wrote the balance and interplay

between country and town that had lent such charm to the living pattern of Georgian and Regency days was being rapidly overset. For it had proved impossible to halt the new mechanized industry at just that point at which it could take up the slack of rural poverty and under-employment. There came, for example, the torrent of urban babies! While the machines, once started, could not be stopped, but proliferated like the population. So long as English economic life had been based essentially on the countryside, and on the supplement to human capacity for work provided by the energy of horses and oxen, wind-mills and water-mills, the population that could be supported was of the order of 5,000,000 or 6,000,000 only. And since nearly four-fifths of these were in some way associated with the land, the towns, except for London, remained small. It was from townsmen, however, that the impulse came towards a new economic pattern of society, one that was to prove compatible with a population increase running up to eight-, nine-, perhaps even tenfold. For since the 17th century there had grown up in the towns a class of skilled and specialized craftsmen of a new type—instrument-makers, scale-makers, engineers and others—who based their work on some knowledge of applied mathematics and physics. Some were employed by the equally new groups of natural philosophers—the scientists, we should call them—who also lived or met together in the towns. It was from the fruitful association of these two sets of men, the educated worker and the original thinker, that the ideas for new machines sprang which put fresh sources of energy at the disposal of the nation. James Watt, for example, was a young instrument-maker employed in Glas-



ner and Stockbreeder

The Eastern Counties have no coal but, none the less, they are sources of vital energy, for in summer they are hotter, drier and sunnier than the rest of England. Hence the large grain crops which make it worth while to use combine harvesters (above) on this Cambridgeshire farm and the thousands of tons of sugar-beet (below), which are unloaded from lorries for feeding into a big sugar factory at Ipswich

Photos





Picture Post Library

(Above) Cowboys ride through the heather on a new cattle-range near Fort William in Inverness-shire. Highland drovers were once a common sight at Lowland cattle-fairs; but when cattle and crofters vanished the pastures gave way to gorse and bracken. Now the process is being reversed, not only in Scotland but (below) in the south, too: near Rye much good farm land would go back to saltings without new sea-walls

The Times



gow University who in the course of business came to ponder over one of Newcomen's primitive, inefficient engines, sent in for repair.

It took nearly two centuries for the wind-mill and water-mill, the ox-team and the horse to become quite outmoded. Indeed until the invention of the internal-combustion engine, the horse remained indispensable both on the road and in the farm. At the turn of the present century we were still using a couple of million horses to work for us, and there were about the same number of agricultural workers. But within these fifty years some half the men on the land and three-quarters of the horses have disappeared. So, too, have about 5,000,000 acres of cultivable land. Nevertheless the war years restored the actual acreage under crops to its earlier extent, so that the loss of land only appears when we examine the category of permanent

pasture. Much of it has vanished under roads, buildings and gardens, under sports fields, golf links and service training-grounds. But a substantial proportion is land once farmed and now neglected, so that it has been invaded by scrub and bracken. The work of hundreds of thousands of horses (fed on annually replaceable oats and hay) is now done by tens of thousands of lorries and tractors (fed on irreplaceable mineral oil), and this has made it possible to do without a corresponding number of horse-keepers and carters, and a corresponding acreage of land required for fodder crops. Much shorter hours, too, are worked on the farm. Yet there is nothing spectacular to show in the way of output for this mechanization, if we look at what the farmers did in 1900. Land that then grew fodder for horses now grows valuable (but subsidized) sugar-beet, and a variety of vegetables for the table; the yield

Scooped out trough-wise by vanished glaciers, Highland glens are ideally shaped for storing up water. The down-rush from Loch Sloy is transformed into electricity on the banks of Loch Lomond

hswood Press Agency



of potatoes is up 50 per cent; while a veritable torrent of milk (like the torrent of medicine which appals the Minister of Health) has replaced the noble sirloin, the saddle of mutton, the leg of pork, that cheered our younger days. But corn-land still averages round about a ton of grain to the acre as it used to do, and there are now 10,000,000 more human mouths to fill, if fewer mangers. Ought not still more energy to be directed towards the land? For a myriad machines will not save a poorly-fed people from going downhill, since poor feeding (even where there is no hunger) spells apathy and listlessness, a slow tempo of work.

Energy, say the mathematicians, is capacity for work. And they define 'work' as applying force to move an object from one place to another, so that it covers a game of golf as neatly as it does lifting potatoes. To measure work done they have defined a 'unit of power', derived from the performance of that old-fashioned worker, the slow-moving cart-horse, plodding along with his load at scarcely two miles an hour, and giving this rhythm to the farm-worker's gait. One horse-power (H.P.) is the energy required to do the work of moving a quarter of a ton weight one foot per second. On this scale Canada possesses an installation of 11,000,000 H.P., obtained by 'harnessing' (the horse again) a variety of her tumbling waters, including the Canadian Falls of the vast Niagara. That total gives a horse-power apiece, at cheap rates, to nearly every man, woman and child, whereas supposing we in Britain were to develop every scrap of our natural water-power it would not give us one unit among fifty people. The output of energy even from our largest hydro-electric plants, such as Loch Sloy, is only of the order of 40,000 to 50,000 H.P., so we have to look elsewhere for means to multiply our capacity for work.

But before asking how we manage, it is worth hearing a little more about energy as the engineer views it. "Energy is immortal", he will tell you (though not in so romantic a phrase), it can neither be created nor destroyed. And while you get your breath to protest against such a fantastic notion, he will bewilder you with qualifications. Though indestructible, energy can be dissipated (scattered, that is to say, in such tiny packets as to be useless); it can be rendered latent and stored indefinitely; it can exist unnoticeably as potential energy (in a boulder on a mountain-side, for example, which a touch may launch on a career of destruction); it can disappear in one form to reappear in another

(as when the energy you put into sawing a block of wood does little more than make the saw hot)—and it can vanish into outer space.

We have not yet discovered how to concentrate the incoming energy arriving daily from the sun so as to make it do mechanical work at some given spot. Mediaeval experimenters like Petrus Peregrinus spent years trying to make a burning-glass powerful enough to scorch up a hostile army, and modern experimenters dream of batteries of mirrors and reflectors in the sun-drenched Sahara. Nevertheless solar energy is stored continuously by plants, and so we ourselves get energy by eating them, and warm ourselves up by burning them; indeed engines have been driven by steam raised from burning coffee-beans. But apart from food, it is the solar energy stored in extremely concentrated form in fossil fuels—coal, oil, peat—that provides our main stand-by, and these fuels took tens of millions of years to accumulate. The circulation of the atmosphere, including that of water vapour, is kept going without pause by solar energy, so that we have at our disposal the potential energy of waters falling from high places, and the intermittent energy of the winds. Growing plants and falling water (apart from the little wind-generators such as those installed in Orkney) are the main sources of our energy income; fossil fuels are capital, once spent they are gone forever. Atomic energy, too, is a form of capital, for we cannot reconstitute an atom once it is split. But the supply of atoms is inexhaustible in any foreseeable length of time, whereas coal and oil may give out in a matter of centuries. As however the atom can as yet only be used for destruction and not to do controlled mechanical work, it must be left out of account. Prudence suggests concentrating attention on those sources of energy which are constantly renewed, more particularly as two of them can be considerably (although not indefinitely) augmented by human effort. Water can be stored behind dams, and plant growth can be stimulated by selecting seed, grading up the land, and other forms of good husbandry. Artificial rain-making, too, at last seems to be just around the corner, and this promises not only more water-power, but an extension into semi-arid regions of cultivable land.

It is the area of cultivable land which is the ultimate limiting factor to a nation's energy, the energy which is supplied by food, conserved by fuel, shelter and clothing. In simpler societies all four necessities were won

from the soil, and so most wars were but the quarrels of kings, but in a machine age fuel takes on a disproportionate and fateful importance. It can no longer just be brought in from the wood-lot. Sir Harold Hartley, who addressed the British Association in 1950 on "Man's Use of Energy", pointed out the gross disparity between energy resources and populations. Two countries, the United States and the Soviet Union, possess quite half the world's visible resources of coal and oil, yet they contain only an eighth of the world's population. As regards the remaining half of these two fuels, Britain and Germany have a disproportionate amount of coal but practically no oil, while Venezuela and the Middle East have a disproportionate amount of oil. In the case of the oil the disproportion is all the greater because the possessing countries have only small and technically backward populations. It has been clearly shown that the general wealth and prosperity of a country bears a close relation to the number of units of mechanical power employed per head of population, and according to Sir Harold Hartley's figures the United States (with enormous water-power as well as coal and oil) runs far in the lead, using twice as much as we do in Britain and forty-five times as much as India or China with their impoverished peasantry.

But our immediate concern is with Britain, and first of all with this fundamental matter of food. At a time when nearly every nation is making plans to develop industry (and so to become our competitors) it is only by supreme skill and inventiveness, by constant advance in science and technics, that we shall hold our own. We must therefore feed for brain rather than brawn, which means with quality rather than quantity of food, with proteins rather than starches. The brain, though so small relative to the whole body, requires a quarter of the energy intake as food to activate its 10,000,000,000 cells. Yet its needs go largely unrecognized. An ancient man, asked how he passed his time, replied: "Sometimes I sits and thinks, sometimes I just sits". The distinction was valid and well observed. Yet for food purposes an Albert Einstein concentrating on an abstruse mathematical problem is put into the same category as the porter stationed all day at the door to forbid unauthorized entry. The criterion is simply posture—both sit, they are alike 'sedentary workers'. It is an amazing fact that while a motorist will take endless pains to feed the correct lubricant and petrol mixture into his car, and the greyhound owner

to feed the correct ration to his dog—for they both recognize that the speed that comes out depends on the energy that goes in—each would think it nonsense to apply the same methods to his children or even to himself. H. G. Wells told us that Mr Polly's parents had spoiled his nice new digestion before he was five years old. And that goes for most of us. To take thought about food is 'greedy' and so our capacity for work, especially for brain-work, is seriously impaired. How often do we look back to the past and say "There were giants in those days!" They fed like giants, and perhaps that is why. Boswell paints an inimitable picture of the Whig John Wilkes helping the Tory Dr Johnson to some fine veal at Mr Dilly's table: "Pray give me leave, Sir,—It is better here—A little of the brown—Some fat, Sir,—A little of the stuffing—Some gravy—Let me have the pleasure of giving you some butter". Here was food to produce Dictionaries and Ramblers! And of himself Boswell relates that after four days' short commons (due to his own imprudence) he ate "prodigiously" at a dinner party, whereupon "We talked entirely in the way of Geniuses. We talked of poetry". What kind of talk would have resulted had Mr Dodsley served his guests with a dish of potatoes and a dab of margarine?

Dr Salaman recently, and the economist McCulloch a century ago, both emphasized the social danger of falling back on the potato, even with milk galore, tempting though this way of feeding a nation is to politicians because of the great bulk yield to the acre. Sugar-beet cropping up to twelve tons to the acre does even better, and makes an even finer show in calories. Could we but live on sugar the anxious problem of the disproportion of people to cultivable land in Britain would be solved. But for living on a generous mixed diet, with plenty of animal proteins, an American expert has calculated that $3\frac{1}{2}$ acres of such land per head (to include pasture) are necessary for every individual. (Canada has no less than 5.) Farming in the United States, however, is extensive rather than intensive, and taking into account the higher yields we get over here we can put the figure at $1\frac{1}{2}$ acres. Even so, Great Britain could only feed up to 20,000,000 people on a good mixed diet, or perhaps 22,000,000 when we take the sea harvest into account, for so much of our 56,250,000 acres of land cannot be classed as cultivable. The figures are easy to remember: in England one-quarter, in Wales one-half, in Scotland three-quarters of



Aeroflms Ltd.

Solemn, dignified, rising like steps to its gently tapering chimneys, Cliff Quay Power Station at Ipswich directs a steady flow of energy to the farthest corners of the thriving city in its rear

the total land surface is not under cultivation, and at best affords rough grazing.

"Maximize energy!" ought to be our slogan, and we should calculate in terms of energy when we hear about the campaign to bring marginal lands back into cultivation, or about the methods which Sir George Stapledon has demonstrated of multiplying the sheep-carrying capacity of our hills and mountains. From time to time we hear their own stories from young men and women who have turned derelict areas into prosperous farm-holdings, and it always proves that their hard work has required energy of brain—in

planning, in imagination and in foresight—almost more than energy of muscle. The same mental qualities are found in the Scottish landowners who are introducing cattle-ranching into the Highlands, in the Yorkshire farmers who are reclaiming rich warp lands by the Ouse and Humber, in the Fenland farmers who join with their neighbours to wall in the fringes of the Wash for cultivation, and in the farmers of Romney Marsh who are likewise pushing back the sea. These are enterprises which no doubt profit the individual, but collectively and by the example they set, they profit the nation even more.



The Scotsman

(Above) The surface layout of the newer mines, as at Comrie in East Fife, is itself designed to save energy, but if the waiting trucks are to be filled with a steady stream of clean coal, it is obvious that the time and energy of skilled men underground must also not be wasted. One answer is the diesel train (below) which at Nook Colliery in Lancashire saves each miner an hour's walk to the coal-face every shift

Daily Herald





The Times

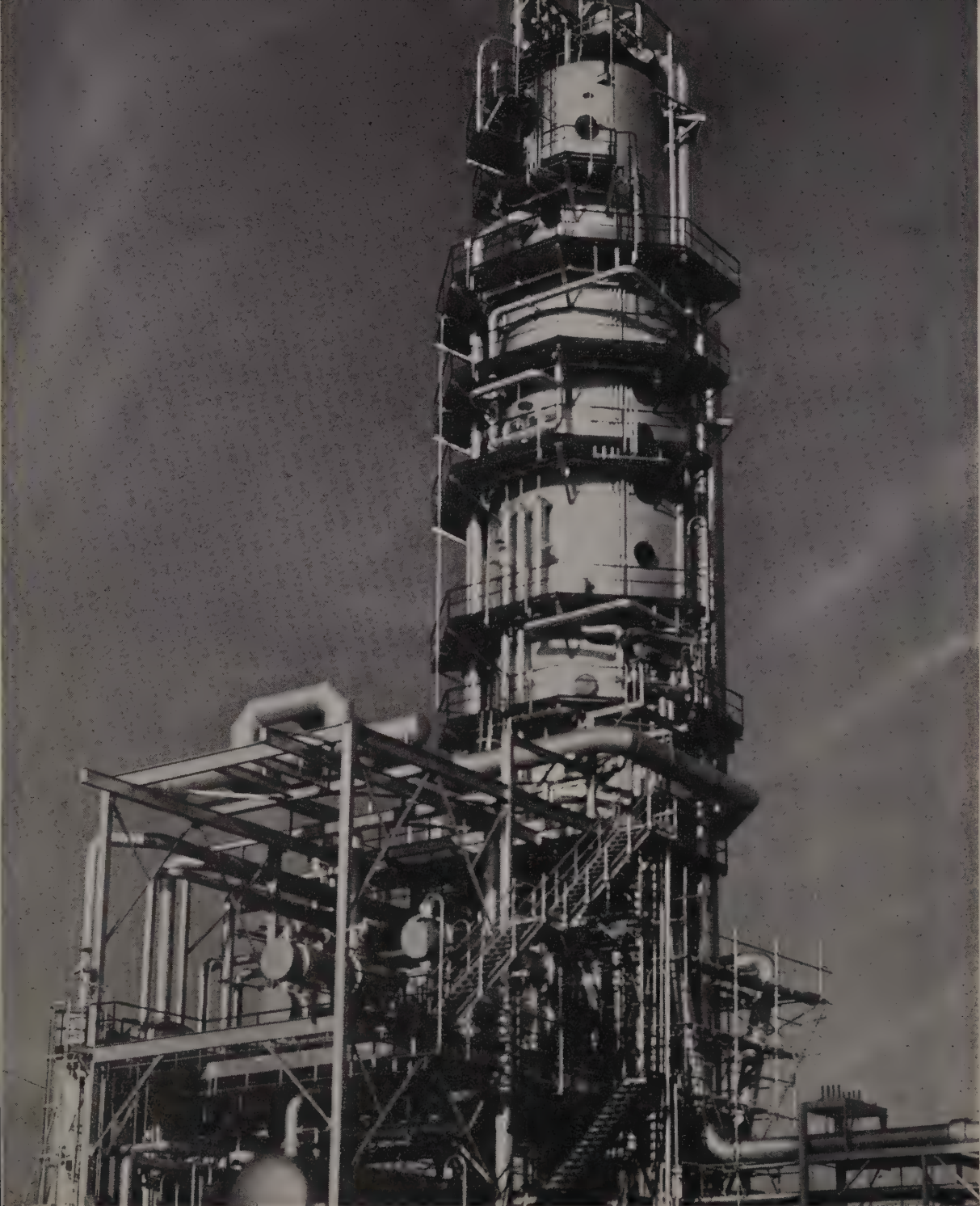
Here is a congeries of strange shapes, dictated not by surrealist fancy but by engineering necessity. Fed continually by coal-barges, this Thames-side gas-plant produces valuable fertilizer in addition to supplying two dependable fuels to myriads of households in Outer London and Kent

It has often been said that supposing the best practice, whether in farming, mining or industry, could be turned into the general practice, the word 'shortage' would virtually disappear.

There are tracts of country, however, which nothing can transform into farm-land, and which yet can be made to 'earn their keep' by reafforestation. Plantations lack the beauty that comes with natural growth, but aesthetic considerations cannot take precedence when we reflect on the part played by lack of timber in the tragic shortage of homes. Nor can the energy resources of the Highlands and Snowdonia be allowed to run to waste because for some of us the landscape will be marred. Disfigurement can be lessened if the advice of a landscape architect is obtained, for he can show how by taking the natural features into account, as well as by planting and screening, even massive new constructions can be made to sink into their background and become inconspicuous. Many of the scars of industry, too, can be removed if the will and the energy are present—we hear

of 'tips' levelled and turned into playgrounds or masked by shrubs, of a quarry transformed into a stadium, a gravel-pit into a pleasure-lake. Again, if only the best practice were to become the general practice!

Short of a population policy which would scatter half of us about the Dominions, we are obliged to multiply our natural hydro-electric power resources tenfold to meet the demand for electricity, and this must be done by steam-driven generators, or thermal-electric power stations as they are called. These power stations cannot be pushed away like gasometers into some wilderness among the railway sidings, for they need such an enormous circulation of water for cooling purposes that they must stand on the river bank in a conspicuous position. Fortunately the giant installation at Battersea on Thames-side, built long before World War II, proved the engineers' contention that such a building can be a fine one, and that there is no need for its tall chimneys to belch out smoke or fumes. The example set has been followed in building handsome power stations wherever



By courtesy of the Anglo-American Oil Co., Ltd.

Complex or simple, the forms of modern industrial architecture have their own extravagant beauty. (Above) An atmospheric heating plant, at the Anglo-American Oil Company's new refinery at Fawley which when complete will have cost over £37,000,000. (Opposite) At the Shell refinery, Ellesmere Port: a cooling tower 340 feet high and spherical tanks for storing liquid butane under pressure



By courtesy of the Shell Photographic Unit

reconstruction or enlargement was necessary, at Ipswich, Stourport, Nottingham, and many other places, to the point indeed of there being complaints that they are "like cathedrals". Yet these represent the transformation of energy rather than any fresh sources, and for our main strength we must still fall back on our coal-fields, which (so we are told) are going to last two hundred years if not a thousand. It is a very remarkable fact that the quantity of coal consumed by our expanding industry and mounting population has remained practically stationary for fifty years, a result largely secured by improving the total efficiency of furnaces and machinery, or in other words through the energy shown by our engineers in their perpetual search for means to ensure that what comes out of any installation in usable heat or power is a reasonable return for what has

gone in as coal or coke. Despite their efforts jets of steam or clouds of black smoke pouring into the atmosphere still tell a lamentable story—waste of energy.

The tonnage of coal used at home has remained steady, and may even in future be reduced, yet the amount available for export (which means a regular income) is a mere fraction of what it was half a century ago. The trade was killed by new inventions and by the changes brought about during World War I, but the wheel has now turned full circle, and it could be revived again were sufficient coal produced, though the number of miners has fallen and is falling still. Yet paradoxically enough, the new blue-print for the industry calls for even smaller man-power, coupled with the promise of a larger output at lower costs! This is to be achieved by further mechanization (already mechanical



Felix Fonteyn, by courtesy of "Progress"

Efficient management and good industrial relations can prevent an incalculable waste of energy. Business executives taking a course at the Administrative Staff College near Henley

hewing and mechanical conveyor-belts are widely installed), and also, and very significantly, by the elimination of unskilled and wasteful labour. This change is in line with what was said earlier in this article—that we must keep our lead by energy of mind and brain, in other words by superior efficiency. There are tremendous human problems involved here, and feeding problems too. And the mining industry has a second intractable human problem to face, for to put it crudely the miners must follow the mines, and the mines are removing eastwards. This at a time when we are all immobilized by the need to cling at all costs to a home, if we are so fortunate as to possess one.

However rich (by comparison with our neighbours) we are in coal, we have to face the handicap, not merely of having no oil-wells of any significant size in Britain, but of the absence of major fields within the Dominions (except possibly in Alberta) or the Colonial Empire—and yet as a source of energy fuel oil is indispensable. True that

the chemical engineers can distil it from coal, and do so at great cost in the big chemical works by the Tees, but this is only to transform energy, not to secure more of it. The best we can do is to import oil in the crude (and therefore the cheapest) form, and refine it (or "crack" it as they say) ourselves, thus securing the whole range of products and valuable by-products. In all our great sea-entries, therefore, there are oil-refineries and oil-storage plants, many of them new, and carefully sited so as not to be too near residential areas for safety, or too far off to secure work-people. The most notable, perhaps, is the huge Anglo-American installation on reclaimed ground on the west side of Southampton water, while at Llandarcy in South Wales a new silhouette has been raised against the sky, looking like a giant chemical laboratory with its retorts and tubes and containers. At Ellesmere Port there is another, at Grangemouth another, on the Isle of Grain near the Medway towns another, processing the energy that will drive a million wheels, producing the

lubricants, too, that prevent waste and loss of efficiency. So far there is no known lubricant (unless it be good food and good industrial relations) guaranteed to step up human efficiency, and so prevent what is undoubtedly an incalculable waste of energy, but it has at last been recognized that it is worth while to relieve the brain of drudgery as well as the muscles by means of machines. The Royal Society recently exhibited a mechanical 'operator' that took on all comers at noughts and crosses, and always won! This was merely a humorous trifle to draw attention to what can be effected by the new electronic 'brains', able to remember, compute, inform, even exercise judgment. But for what purpose is all this energy being won or transformed or saved? Said Sir Harold Hartley: "In the future one of the indexes of economic progress should be, not the energy used per worker, but the output of goods and services per horse-power employed". The use we make of our energy will be the subject of my next article.

The Church in Ethiopian Life

by CHRISTINE SANDFORD

In developing her theme, the author draws on nearly thirty years' experience of Ethiopia, shared with her husband who led patriot troops against the Italians and holds a high position in the Ethiopian administration. Readers wishing to learn more about recent Ethiopian history and other aspects of the country's life may turn with benefit to her book Ethiopia Under Haile Selassie

CHRISTIANITY in Ethiopia dates back to the 4th century, an earlier conversion than that of Britain at the visit of St Augustine, and the influence of the church both on the history of Ethiopia and on the lives of her people has been all-pervading. St Frumentius was shipwrecked as a boy on the coast of the Red Sea; he lived as a slave at the Amhara court at Axum, where he rose to a position of trust and importance as tutor to the king's son. He was sent at the king's bidding back to Egypt, where the Patriarch, St Athanasius, consecrated him as Bishop and returned him to Ethiopia to be the founder of its Christian Church.

An isolated fortress of Christianity in the middle of pagan Africa, the Empire of Ethiopia through all the vicissitudes of its history has maintained a close connection between Church and State, and witness is borne to this by the motto and title of the Emperor: "The Lion of the Tribe of Judah hath prevailed. Haile Selassie the First, Elect of God, King of the Kings of Ethiopia". It is not therefore surprising that the Church is held in the highest respect by the people, and that her influence on the life of the ordinary Ethiopian Christian has been paramount. From birth to death, and even for seven years after that, each individual Christian is the care of his parish church and its priests. For, as in England, the whole country is divided into parishes, and the priests of each church are responsible for the population of the district.

After the birth of a child the priest will visit the house to sprinkle it, and all within, with Holy Water, and to bless the parents; he will then arrange for its baptism, forty days later for a boy, eighty days for a girl. If the baptism is to be on a Sunday or ordinary weekday, the parents will take the child to the church at dawn; but if it is on a fast day (Wednesday and Friday of every week) they will not go till eleven in the morning. The ceremony is elaborate. Each child must have his god-parent, a 'Christian-father (or mother)' as the case may be, and the mother must have prepared beforehand the twisted

threads for the 'neck-cord' which every Christian wears. The actual baptism takes place not in the church but in a separate building which contains the font. The child is held out to the four points of the compass by an assistant deacon and given his 'church-name' which is chosen by the priest, who then pours water over his cross onto the baby and repeats his name. The godparent stands by and swears that he or she will not be separated from the child. The neck-cord is then tied on, and the baby is carried from the Baptistry into the church and anointed. On both these occasions the name is repeated four times, and the Eucharist is then administered by the priest placing a small portion of the consecrated bread, which has been dipped in the wine, in the child's mouth. The day of baptism remains an honoured anniversary.

Until the beginning of this century all education was in the hands of the Church, and those who could not afford to engage a priest as private tutor for their children would send them, if they wished them to become literate, to the church. There a priest or *debtera* ('choirman') may undertake the training of some thirty or more children, usually boys, in reading, writing and the reciting of the Psalter. But the many government schools now established in Addis Ababa and most of the provincial towns are providing a wider curriculum of education, and there are at the moment some 50,000 children receiving such secular instruction. In the more remote country districts, where the children are unable to reach any government school, there may still be found groups of boys gathered round the priest as he sits with his fly-whisk and his Psalter on the grassy mounds round about the village church. The system is age-old. The first one or two boys to be instructed are immediately used to teach the newcomers their alphabet, which is written out (seven forms to each letter) on a card that also contains combinations of letters, and finally the Lord's Prayer. When this is mastered the Psalter is begun. When the boy has finished the whole of "David", as it is called, the priest will send to the father

for his reward, a cow or fifteen dollars. There are no other fees.

When a young man decides to marry and to set up his own house for himself and his wife, they will need to have a 'confessor' or, as the Ethiopian title explains, a 'soul's father'. He will ask one of the priests of his parish church to undertake this duty and the confessor will come to the house, bless it and sprinkle it and all within with Holy Water. For this service the 'soul-child' will give him some present each year—a horn cup or head-scarf if he is a poor man, a cloak or a mule if he is rich. At Easter and at the Feast of the Assumption in August he will send him a present of parched corn or chick-peas—food useful in the fast—as his right. The 'soul-father' will act as confessor to his 'soul-children', absolving them after repentance either in the church, or walking outside in the churchyard, and can order a fast or alms to be distributed amongst the poor as a penance. He cannot absolve from murder for which the Abuna (or Primate of the Ethiopian Church) in Addis Ababa can alone grant absolution.

The confessor is also present at a deathbed to give absolution and to hear how a man wishes to dispose of his property either orally or in writing. In the latter case the will or testament will remain in the custody of the confessor until forty days after the man's death, when he will read it aloud to his heirs.

It is curious that, living as they do so much

under the influence of their Church, the Ethiopians disregard the requirements of the Church with regard to marriage. The ordinary practice of Ethiopian Christians is to contract a civil marriage, which can easily be dissolved. Very few except the priests themselves and some members of the nobility are married in church, though it is not rare for older married people who have settled down in life to validate their civil marriage in the eyes of the Church by promising a life-long fidelity and taking together the sacrament of the Eucharist. Only those whose marriage tie is validated in this way or by a church marriage are allowed to partake of the Sacrament; those civilly married are forbidden to do so. The result is that the majority of Christian Ethiopians are non-communicants, and it is taken as a matter of course that only a few should ever partake of the Sacrament.

At the civil marriage, which takes place first in the house of the bride's father, the confessor of her family will be present and say prayers over the married couple, blessing them. Thus this civil marriage-contract is given the approval of the Church and is almost universally practised, with the consequences of a frequent and easy divorce. Marriage in church is indissoluble.

If a well-to-do man dies, the priests together with the deacons and *deberas* may come to his house to recite the Psalter and

read the first part of the funeral service. They then escort the funeral procession to the cemetery, setting down the bier seven times on the way, at each stop reciting further portions from the funeral service. But for each of these seven absolutions the priests receive payment; in the case therefore of poorer people, the priests await the corpse at the church and the bier is set down for absolution and the funeral service is read quickly by three or four priests together, as the body is lowered into the grave.

The rich will hold a memorial feast for the dead on the third, seventh, twelfth, fortieth and eightieth day after his death, and again after six months, one year and seven years. Bread, beer, hot sauces of meat and vegetables are carried to the so-called "grave-



A. J. Thornton



All photographs by Paul and Jean Pichonnier

The Ethiopian Church has points of resemblance to the Church of England, one being that the country is divided into parishes. From the priests of the parish church there is found for each Christian a father-confessor, his "soul's father", to watch over his spiritual welfare. Priests may be known from the white turbans they wear as head-dress and each carries with him a small cross, usually of silver, but sometimes of iron or wood, which he uses in giving a blessing. He first touches the forehead (above) and then holds it to the mouth to be kissed. In many such ways priests encouraged the troops fighting in 1935-36 and again in 1941, and their inspiration helped the patriots to hold out during the Italian occupation



Fasilidas, Emperor of Ethiopia, built this castle in the middle of the 17th century at Gondar, which he made his capital. Gondar remained the emperors' seat during the 18th and early 19th centuries, possessing many churches—forty-four, it is said—and has ever since been a place of learning where many priests go to study. Priests usually carry a fly-switch as well as a cross: this is often covered with a cloth when not in use

The most holy part of the church is the portable altar, a small slab of wood or stone. This is kept in a flat square box which is called the tabot—the name given to the Ark of the Covenant of the Jews. On great festivals these, covered with a cloth, are carried on the head of a priest in procession round the outside of the church. Gay umbrellas are a mark of dignity. The priest in front is carrying a censer



One of the customs peculiar to the Ethiopian Church is the 'dance of the priests', though in fact it is usually performed by 'choirmen', not by priests. Holding in the left hand the crutch with which they support themselves while standing throughout the long services, and in the right hand a sistrum, the two opposing lines of dancers advance and retire to the rhythm of their chants or the measured clash of the sistrums





The rhythm of the dance is further marked by the beat of drums of which four may be in use, one at either end of each line



Women and girls, whose high-pitched trilling accompanies the emergence of the tabot from an Ethiopian Church on festival occasions, may even break into a dance on their own, as a complement to the official ceremony. The dance here shown—

—is used at times of great rejoicing, such as a wedding. Two girls dance facing each other with hands on hips; the rest surround them, clapping hands to mark the rhythm. (Below) An Ethiopian piper with his flute, made of bamboo





Heir to a long Christian tradition—including that of Prester John, the priest-king of mediaeval legend—His Imperial Majesty Haile Selassie I is keenly interested in education as vital to Ethiopia's progress and independent survival in the modern world

house", outside the church, to be partaken of by the priest who is the confessor of the family and such other priests and debteras who may be there; or money may be paid to the church to hold the feast and invite the poor to share it. At the same time the name of the dead man is called out by the priests within the church, so that his sins may be pardoned. The amount of food thus provided increases at each commemoration and it is indeed only the rich who are able to provide the full number of *taskars* or memorial feasts.

It will be clear from the above that the influence of the Church follows each man throughout his life and that as a result there must be many clergy to carry out, not only the congregational services of the Church, but the personal services to each family. The approximate number of churches is between 8000 and 10,000 throughout the country and the estimated number of priests, deacons and debteras is about 2,000,000 out of a total population of about 11,000,000. For though the chief services have been enumerated above there are many other occasions on which the blessing of a priest is required. For example a well in a compound in a town was found to contain a dead rat. It was removed and all the water baled out. The well refilled the following day, but could not be used until it had been blessed by a priest. Standing by the well, with an enamel bucket of water beside him, the priest of the parish church recited prayers for some five minutes or so and then breathed twice on the bucket; after more prayers he breathed again. Continuing his prayers he faced towards the four points of the compass, passing his benediction cross before him. He then bent towards the bucket and spat slightly into it, after which the contents were poured down the well. The next day, as bad luck would have it, a cat fell into the same well and so the whole process of blessing had to be repeated.

The feasts and fasts of the Ethiopian Church are many and regulate the lives of their parishioners. The chief of these are those of the Epiphany in January, Easter, and the Holy Cross in September. But in each month there are days set apart in memory of the Virgin Mary, St George, St Michael and the Nativity of our Lord, and these days assume special importance twice during the year when the churches are crowded at the early morning celebrations of the Eucharist—the only service which laity are expected to attend. All over the countryside on these particular days of each month

the peasants refrain from ploughing, sowing or threshing as well as on both Saturday and Sunday.

The feast of the Epiphany on January 19, commemorates the Baptism of Our Lord, and on this occasion the *tabot* or ark, round which centres the worship and veneration of each church, is carried from the Sanctuary down to the nearest running water, where it is placed in a tent towards evening. All night the clergy of the church intone psalms and prayers. In the early hours, the priests with the ark draped in a rich cloth and carried on the head of one of the priests assemble on the river bank. A wooden cross with lighted tapers on each arm is set afloat on the water and the priests, having read the Gospel and said prayers, bless the water with their benediction crosses and sprinkle it on the bystanders. After the religious ceremony there is much merriment and rejoicing, the people throwing the water over themselves and their friends—some even jumping in—before they go home to feast. At this time also the game of *guks* is played, where one rider chases another, aiming at him with spears or clods of earth, which he must fend off with his leather embossed shield as the two ponies gallop along together.

The services in Holy Week, which are well attended, culminate in the Easter celebrations, when the churches are crowded with worshippers, taking part in the many processions round the interior of the church with lighted candles, and chanting prayers. At midnight, to the sound of clapping and rejoicing, the bell rings from the belfry outside the church and the Midnight Mass begins. It is over at about 1 a.m., and, after blessing the people, the priests depart and the services for Easter are over.

The feast of the Holy Cross, which marks the end of the rainy season, seems to have developed into an almost wholly secular festival. The Emperor holds a review of his chief men and retainers, who pass before him and then march three times round a kind of maypole, set up in an open space, its top decorated with the yellow flowers that cover the countryside at this season and are called "the Flower of the Cross". As they pass by, they throw down the sticks they carry, which also have flowers tied to them, around the central pole. Finally the priests pass round with their crosses and censers and bless the pile. When it is dark, the sticks will be lighted, and at the same time in front of every house a small bonfire will be kindled, and sticks and torches thrown upon it. The

explanation of the ceremony is that it commemorates the bonfires lit by the Empress Helena on the hills of Judaea, when she found the true Cross. These were seen in Constantinople and conveyed to the people there the news of the discovery.

All these festivals are universally observed and are an expression of the people's loyalty to the faith which they have preserved over so many centuries.

In Gojjam and Shoa, although there are modern tendencies towards a cruciform design, the form of the churches is usually circular. In the centre there is a square Sanctuary, either walled or curtained off, in which the tabot is placed. This is a wooden case inside which rests a slab of stone or alabaster, on which words from the Scriptures are carved. It is to the Ethiopian Christian what the Ark of the Covenant was to the Jews. It is held in the greatest veneration. No church is consecrated until a tabot, consecrated itself by resting in another church, has been brought to it. Covered by a rich cloth it is carried in procession on days of special solemnity, and no-one except the priests is allowed to touch it.

Into the Sanctuary only the priests may enter to celebrate the Eucharist. Round it is a circular ambulatory, usually carpeted, to which are admitted those who partake of the Sacrament, or men of special note. Round this again is a second ambulatory, curtained off on the south side, where the congregation stands—there are no chairs—the women being separated from the men. The walls are painted in bright colours with scenes from the Old and New Testament and the lives of the Saints. The centre of the thatched or corrugated iron roof is frequently crowned by one or more ostrich eggs or glass bulbs.

There is no endowment of the Church as a whole; all endowments belong to the parish churches. The clergy are dependent for their livelihood on such endowments, which usually include land allotted to them in the vicinity of the church; and it is estimated that about one third of all the land in the country is held by the Church in this way. They also enjoy the fees and offerings made to them for the services they render.

The ministry of the Church is in the hands of priests, deacons and debteras. The latter approximate to choirmen and their duty is to intone the chants at the daily offices and at other services at which a priest must always be present. Their chanting is frequently accompanied by a drum and they themselves hold a sistrum in their left hands; while for

the 'dances of the priests', performed at the great festivals of Epiphany, Easter and the Holy Cross, they use the crutch sticks (on which they rest during the long hours of service) to mark the rhythm of their movements. Among these debteras are to be found some of the most learned men of the Church, for the long training necessary to acquire a knowledge of the chants and words for each of the great variety of services in use gives them more opportunity of learning and studying at the monasteries than is afforded to those who qualify for the priesthood—a much shorter process. The deacons are unmarried and in order to ensure against any profanation of the service of the Sanctuary only boys are used in this office, who cease to officiate on reaching the age of manhood. There is then a short period before marriage, which is a necessary preliminary to ordination. A priest whose wife dies is not allowed to remarry, though he may continue his work as long as he remains unmarried.

The training for the deaconate and priesthood has in recent years been made more thorough and greater discrimination is used in accepting candidates for ordination. A Theological College has been founded in Addis Ababa for the further education of selected priests and deacons; and some of the more advanced students have been sent for education abroad.

In the past it has always been the custom for the Abuna to be an Egyptian Coptic priest appointed and consecrated by the Patriarch of the Coptic Church in Egypt. Since the present Emperor came to the throne, however, he and his Government have worked steadily to secure greater independence for their Church; and long negotiations culminated two years ago in an amicable agreement that on the death of Kyrillos, the then Abuna, the new and future Primates should be chosen by the Ethiopians themselves and approved by the Emperor and then in due course consecrated by the Patriarch in Egypt. This break with the past has now occurred. Abuna Kyrillos has died and a specially appointed electoral body consisting of the Synod of Bishops, the Council of State, Ministers and others has met recently and elected Basileas, Bishop of Shoa, to be the new Primate.

In the awakening of the Ethiopian peoples which the world is now witnessing it looks as though the importance of their Church in the life of the country, with which it is bound up more closely than in many other Christian lands, is likely to be maintained.

Castles in Cilicia

by JOHN THOMSON

T. E. Lawrence and Robin Fedden, as well as several French writers, have described the castles built by the Crusaders in Syria and Palestine, but those erected by their Christian neighbours in the Armenian kingdom of Cilicia have been neglected. We believe that the author is the first to examine them systematically and that this is the first general account of them to be published

DURING the 10th and 11th centuries A.D. two great forces met head on in eastern Asia Minor: the Seljuk Turks were battering against the outworks of the Byzantine empire. Turkish pressure had been building up for some time, but the ancient empire of the East had faced worse dangers before, and the Arab raids from the south-east seemed the greater threat. The Arabs with their base in Syria struck through the mountain-passes of the Taurus at the heart of the empire, but were by no means uniformly successful, and suffered severe reverses. Strategically the key to the situation was the Taurus passes and the rich Cilician plain which lay enclosed between the mountains and the sea. Yet despite the constant fighting Cilicia was a rich province, for the soil is so fertile that manure is scarcely necessary and as it was the most

practicable corridor between Syria and Asia Minor its ancient cities were strong in commerce.

The kingdom of Armenia, occupying a large area in the neighbourhood of Lake Van, found itself in the unhappy position of being the no-man's-land between the Turkish and Byzantine empires. The Armenian kings nominally owed allegiance to both powers, but in fact at every opportunity they asserted their independence. The Armenians were a hardy, proud race inured to constant fighting and desperate in the defence of their Christian creed, which differed both from that of Rome and that of Constantinople. Frequently the king had little control over his turbulent baronage and his country was often split between the two neighbouring empires, yet the nationhood of the Armenians was





All photographs, except one, by the author

Namrun in the Taurus mountains was the seat of one of the largest and most rebellious baronies of Cilicia. The castle stands on a great rock, a site of immense natural strength, long used for defence. Isolated by a moat cut in solid rock, on three sides the cliffs fall sheer from the smooth masonry of its walls



maintained through their devotion to their religion.

Towards the middle of the 11th century the pressure upon Armenia became intolerable, and since the people for the most part stubbornly refused to be assimilated they had to move. The Greek emperor offered them asylum and a position in exchange for their frontier territories. So the Armenians settled mainly in the region of Caesarea, but their long-standing differences with the Greeks proved intractable. Presently the Armenian king heard that a Greek bishop had named his dog Armen. The frightened bishop was invited to dinner and denied the story, but the dog answered to the name so bishop and dog were enclosed within one sack until they had compassed each other's death. In revenge the king was assassinated and once again the Armenians had to move. Led by some of the greater barons, one of whom founded a new dynasty, they migrated southwards to the Taurus range. There they established themselves on rock-ridges high above the narrow passes, expelling both Greek and Arab from these desolate strongholds. Scarcely had they achieved their new refuge when the foundations of the world were shaken by the Turkish victory over the Byzantine forces at Manzikert in 1071. Immediately almost the whole of Asia Minor fell to the conquerors and they established their capital as far west as Nicaea. Thus the Armenians perched in their mountain fastnesses looked down upon the battlefield where three giants contended. The Arab power held all the eastern Mediterranean and stretched far beyond into Mesopotamia; the Turks now held the huge Anatolian plain, rapidly decaying into a desert; while finally the reviving Byzantine empire pushed forward along the southern edge of this plain in an effort to regain its lost provinces. The focus upon which these forces converged was the Cilician plain, wedged between the Taurus and the sea and approached by scarcely more than a handful of mountain passes.

Once again the Armenians found they were the nut between the nut-crackers, but this time they held several of the vital passes and could debouch at will upon the plain. During the three centuries of its existence the Armenian kingdom of Cilicia enjoyed few years of peace; consequently the building and maintenance of castles became a prime necessity. No doubt the Armenians had a native tradition of their own, influenced apparently by Byzantine models, but it seems almost certain that their style developed

considerably upon the arrival of unexpected new allies. In the summer of 1097 the First Crusade fought its way across Asia Minor and a portion of it descended into the Cilician plain. At this time the Armenians were still confined to the mountains but they sent a contingent to help at the siege of Antioch. When the precarious kingdom of Jerusalem was established, the relations between the two kingdoms were frequently marred by treachery and jealousy, but they needed each other too much ever to quarrel irrevocably. They were both Christian states and they faced the same enemies; eventually they were both ruled, nominally at least, by branches of the Lusignan family; and they were defended by the same Military Orders. It is not therefore surprising that their military architecture was in many ways similar.

Nothing is so characteristic of the early Cilician castles as their position upon terrifying rock-ridges. The cliffs at Namrun, for example, are typical of the rock-ramparts which sheltered the Armenians when the invading Seljuk, Byzantine or Arab armies swept the plains. Many of the positions are so strong by nature that they could be defended by a single man with a crowbar standing at the top of the path, and certainly light defensive walls were quite sufficient in many places. But on the exposed side the Armenians sometimes ranged two or three lines of fortifications. Their mature work shows considerable skill in positioning with large boldly projecting round towers that provided flanking fire, with entrance gates in re-entrant angles, and concealed posterns. They built solidly, for the most part in ashlar or rusticated ashlar. Their masonry is usually beautifully squared and smoothed, and their pride in it is shown by the frequent individual mason's marks.

The second king of the Cilician dynasty established his capital at Vagha, deep in the ranges of the northern Taurus. The castle is raised high on a rock-ridge above a pass through to the Anatolian plain. At one point the path along the ridge narrows to only a foot in width and leads beside a sheer precipice; yet the entrance arrangement is complicated and reminiscent of the great Crusader masterpiece Crac des Chevaliers.

I first saw the walls and bastions of this forgotten capital in the afternoon sun as I and my escort of one corporal clattered round the corner of a deserted road which every instant seemed on the point of sliding precipitately into a brawling green torrent far below. As our army horses climbed the steep hill we passed two ruined churches and a dozen or so



At Sis (above) the last king of Cilicia was captured by the Mamelukes in 1375. It is one of the few Cilician castles with a continuous stretch of machicolation and has, like most of them, a vast underground cistern. Savranda (below), which is probably of Crusader origin, is very similar in masonry and detail





The boldly projecting bastions of Irlan Kale show a development in castle design: its builders had rediscovered that defence need not be passive. Its triple line of defence on the exposed side is skilfully adjusted to the contours of the ridge. (Below) The isolated block to the right was a Christian chapel



rude huts, from one of which we collected a guide. The castle was clearly reserved for goats and stray historians. I photographed and planned the castle, meanwhile keeping my escort and guide amused by setting them to explore an underground passage and measure an impressive underground cistern. At sunset we descended and having eaten a delicious meal at our guide's hut, where I was entertained as if I was the baron of the castle, we slowly picked our way down the hill in darkness. Finally the moon arose at the throat of the gorge down which we trotted towards the sleeping village.

I migrated, as the Armenians had formerly done, from Vagha to Sis, their greatest capital. I spent three days alone, except for the kestrels, in exploring the massive defences of Sis, the underground cisterns, the store-houses, the living-quarters and the royal apartments. These latter stood at the end of the ridge where it fell to the walls and bastions of the outer wards. The empty windows upon the one hand look out on the vast fertile plain, dotted with rock-ridges, and upon the other gaze on the jagged ranges of the Taurus.

As the Armenians advanced into the plain they found and built upon the sites of ancient civilizations. The rock-ridge castle of Anavarza is over a mile in length from outpost to outpost and obviously had once been used by the Byzantines; there are also the remains of what appears to have been a Roman temple. From here one looks down on the sarcophagi and triumphal arch of an ancient city still surrounded by its double walls upon which three aqueducts converge. Further east, above the river Ceyhan, the mediaeval castle of Bodrum presides over the columns of a Roman triumphal way with beyond them temples, baths and a theatre. Today the place is deserted save for an occasional goat-herd. This castle was occupied by the Knights of St John; for more and more the Cilician kings like their neighbours of Jerusalem were glad to hand over the custody of certain strong places to the relentless courage and determination of the Military Orders. For more than a century Crusaders continued to trickle across Asia Minor into Cilicia, but they never came in sufficient force to secure the permanent safety of the Christian kingdoms of the East.

For nearly three months I criss-crossed Cilicia in the tracks of the Crusaders, and penetrated eastwards almost as far as the Euphrates, sometimes galloping across the plain, sometimes trotting through moonlit passes, or jolting interminable hours over hill-

tracks in decrepit lorries. The scenery was often wild and beautiful with rushing streams, pine-woods and impressive hills, often also barren and stony. The horses and donkeys are wonderfully surefooted, but nevertheless much attention is sometimes required to avoid Absalom's fate or to negotiate a ford.

It was in a particularly wild area that I came upon Savranda Kale, a castle rarely visited since the Middle Ages. Astride a white horse with a huge saddle I felt in very truth a crusader as I rode up to the gate, at the head of my little escort. But feelings can vary as much as the scenery does, and as suddenly. I had an experience of quite another kind while I was exploring Toprak Kale, a castle of Western pattern which stands on an ancient site at the throat of the narrow passage between Cilicia and Lebanon. Suddenly a posse of twelve or fifteen men burst into the castle with rifles and revolvers at the ready. Fortunately I saw them before they saw me and by dint of shouting "*İngiliz*" very loud and clear prevented their wrath. It transpired that someone having seen me reported that a dangerous smuggler or gun-runner was hiding in the castle, no very unlikely occurrence in the frontier regions.

Of the thirty or so castles I investigated there was perhaps only one which was not in visual communication with another. Irlan Kale is one of the nodal points in this network of communications and today a railway and main road run near it, but it is not easy of access, for it lies in a huge bend of the river Ceyhan. I found a ford where the water did not come above my middle and by which I crossed three times, once in moonlight and once in the company of a herd of cattle. Its walls and towers, sinuously moulded to the contours of a sharp rock-ridge, make Irlan Kale (Castle of the Snake) one of the most formidable of castles and a favourite of mine. The path leads sharply up through three lines of fortifications and, its ascent not being an exertion to be lightly undertaken, I spent a night on a bastion of the inner ward. There is great peace and some excitement too in having a large castle to yourself. The whole building was brilliantly lit by moonlight which penetrated into the tiny chapel where the fragments of a much-damaged fresco can still be discerned.

Back on the main road below I headed westward through Misis, Adana, Tarsus and Mersin. It is at Mersin that the Taurus range begins to swing down towards the sea, and the plain narrows to a mere coastal strip beautifully planted with gardens of orange, lemon and banana trees. The road

presently enters rougher country and leads between the arches of a colossal Roman aqueduct, while the inland hills are dotted with square pirate towers. In these hills are the two curious holes known as Heaven and Hell; and then after running for two kilometres through the deserted Roman town of Elaeusa Sebaste the road suddenly turns a corner and comes upon an enchanted bay. In the centre of it is an island defended by the walls and towers of a mediaeval castle of which the Turks tell a romantic story. The king of Gorighos, they say, for such was the name of the place, had an only daughter of peerless beauty of whom it was prophesied at her birth that she would die by the bite of a snake. To avert this catastrophe the king built a castle upon the island and there he kept his daughter virtually a prisoner. But Fate was not to be balked and a snake accidentally introduced in a basket of vegetables proved the prophecy true.

At one horn of the bay there is another and larger castle defended by a rock-moat and a double circuit of walls. It is an ancient site and the present castle has undergone much alteration. Perhaps the graceful entrance arch is Byzantine, and of the two chapels one appears to be Romanesque and the other late Gothic.

I stayed with the *gendarme* in a little white house looking out on the limpid blue of the bay. He had a gramophone with eight or nine records, but only the simplest of food to eat.

My next stage was Silifke, the ancient Seleucia, a prosperous small town dominated by a large mediaeval castle. The interior of the castle is a wilderness of rubble, but most of the vast undercrofts still stand, some of them almost a hundred paces in length. It was within sight of this castle that Frederick Barbarossa, leading the German contingent to the Third Crusade, was drowned while bathing.

Hiring a fishing-boat I visited a deserted island where I found a Roman coin and the ruins of a sea-coast village, and whence I saw several castles on the mainland. Next day I jolted for twelve hours in a crowded truck over roads of a badness to be expected in the inland hills before plunging into the humid heat of the little town of Anamour, the most southerly point of Turkey. The return journey was even longer and more eventful. Once I looked over the side of the lorry and saw a wheel rolling down the mountain path: immediately I was sharply reminded that it was one of our own. The engine broke down incessantly; once, so I was





With three wards, thirty-six towers, a moat and its own tiny harbour, Anamur on the Cilician coast was capable of prolonged defence. Since mining was probably impracticable here nothing but a frontal assault with fierce flanking fire could avail against it. (Below) The great fourteen-sided tower was the first line of defence and in the curtain-wall alongside it there is a double tier of galleries with loopholes





Professor A. W. Lawrence, by courtesy of the Courtauld Ins

At Gorighos, also on the coast, there are two castles. One is on the mainland; in it Roman, Byzantine, Armenian and Crusader work are blended. The other, on an island in the bay, is mediaeval

told, for lack of water which seemed ironical as we huddled over a fire of pine twigs in an attempt to dry our sopping clothes.

But Anamour was splendid. I had been visiting another castle of unexpected merit and extent which so delayed me that I found myself some considerable distance from my destination when night fell. Presently I came upon a small coastal village with a high bridge over the river. Here a young man entertained me in the coffee-house and gave me a lodging for the night. We rose at four the next morning and having filled an earthen jar with water and crammed our pockets with bread and cheese we sallied forth. A donkey was provided for me, but my companion, on his way to enlist in the army, was soon striding far ahead. There was a nip in the air and placid though the tread of my donkey was, yet on this cliff road leading through pine trees it seemed to ring forth adventure. The moon arose and revealed the dark anatomy of the hills. Once we exchanged a greeting with two men driving a string of mules. The morning star had risen when we saw the dark bulk of Anamour castle squat and massive on the coast. Just then we came upon two men rising from their bed under a thorn tree; we joined in collect-

ing twigs, and piling on straw we soon had a merry blaze round which we all crouched and breakfasted off thin layers of bread, like sheets of brown paper, but tasting good.

Soon the sound of chattering was heard and several families driving camels and donkeys came down the road. We stamped out the fire and having said farewell my companions journeyed on to the little town some kilometres further. I sat down to await the dawn which presently came sliding across the waves, tinting the towers of the castle. At that I arose and walked across the virgin sand beneath the huge fourteen-sided tower until I found a breach in the sea-wall through which I entered the colossal castle which may perhaps have been the last stronghold of the Cilician kingdom.

In the 14th century the direct line of succession failed and the Armenian crown went to a branch of the Lusignans of Cyprus who for two generations battled against the rising tide of Arab invasion. Finally in 1375 the Mamelukes of Egypt overran the whole country and captured the king. One or two of the coastal fortresses, supplied from Cyprus, held out for a time, but the history of the fantastic little kingdom of Cilicia had come to an end.

New Riches from the Sea

by DR F. NEVILLE WOODWARD

A fresh supply of raw material, from a hitherto neglected source in our own country, is a matter of interest to us all. Dr Woodward, Director of the Scottish Seaweed Research Association, shows the rapid strides made of late towards providing one, aided by the efforts of the Association

WHEN in 1942 Britain appeared to be in danger of being cut off from her supplies of Indian jute a rapid search was made for a home-produced substitute fibre from which a fabric could be made suitable for Army and Navy camouflage purposes.

At the time, the difficulty seemed unsurmountable as British agriculture and industry were stretched almost to breaking-point and no land crop could possibly be diverted from the essential task of food production. All sorts of possible substitutes ranging from nettles to coal-dust were suggested, examined and rejected for one reason or another and it was not until those responsible looked to the sea as a possible means of providing the desired substitute that any glimmer of hope was seen. The use of seaweed as a rough and ready means of camouflaging ammunition dumps, army stores, etc., had already been suggested although it was soon dismissed as impracticable, mainly on account of the ease with which it decomposed. In view of the fact that seaweed appeared to be an abundant and unused crop, other possible ways of using it were explored; and as a result it was found that seaweed contained a peculiar chemical called alginic acid, from which C. W. Bonniksen, a London University scientist, had succeeded in producing a Cellophane-like material in small quantities in an experimental plant at Slough, several years before the war. As the process of making Cellophane is not unlike that employed in rayon production, it was logical to determine whether a fibre could be spun from the acid, that could subsequently be woven into the badly-needed camouflage fabric.

It was found that fibres of a sort could be spun, although those first produced experimentally in the bedroom laboratory of a requisitioned mansion in Leamington Spa looked most unpromising; for one thing they practically disappeared when left out in the rain! However, after months of patient experimentation by teams of industrial, university and government scientists working in collaboration, a fibre was produced which not only did not dissolve in the rain but did adequately replace Hessian scrim and, in

addition, had the most desirable property of being fire-resistant. The need for the material passed with the end of the war, but the work leading to its production convinced many that the sea holds more riches than had previously been imagined.

It is remarkable that, with the exception of the fishing industry, marine resources had hitherto been almost completely overlooked as a source of supply of food and of starting-materials for industry. There were, of course, many reasons for this. Why should the virtually unknown depths of the ocean be explored, with all the attendant risks, when it is relatively easy to win minerals and fuel from the land and grow there the crops and animals which for generations have fed the world?

Two major wars in one generation and the pressure of increasing population have altered that. For the first time in history there are practically no new lands to discover and exploit. This, coupled with the fact that, largely as a result of improved living-conditions and recent advances in medical science, the world's population is increasing at the rate of 55,000 per day, is forcing economists, industrialists and scientists to explore hitherto unexploited areas and resources for their basic commodities. Because of the success of the camouflage-from-seaweed work and the rapid advances made in the young but vigorous science of marine biology, the oceans and all that they contain are now receiving more attention than ever before. Nearly three-quarters of the earth's surface is covered by sea, which contains all the minerals required for life and compares favourably with soil in fertility. Acre for acre it is more productive than the land and there is no danger of drought or violent temperature-fluctuations and relatively little fear of disease.

It has been estimated that over 400,000,000,000 tons of carbon dioxide are extracted from the air each year and converted by sunlight into marine organisms, principal amongst which are plankton, the microscopic floating plants and animals which make up the basic diet of fish, and the

seaweeds. Of this vast annual production of aquatic life, less than 1 part in 100,000 is caught by the fishing fleets, and of the seaweed crop, until recently, virtually nothing was used.

WHERE SEAWEED GROWS

Most people's acquaintance with seaweed is limited to what they have seen, and possibly smelt, whilst spending their summer holidays at the seaside. In the hot summer months the rotting odoriferous fringe of dark brown 'foot-balls and shoe-laces' which are to be seen on most rocky shores is frequently all too evident although the seaweed 'forests' under the water are never seen and few are aware of their existence.

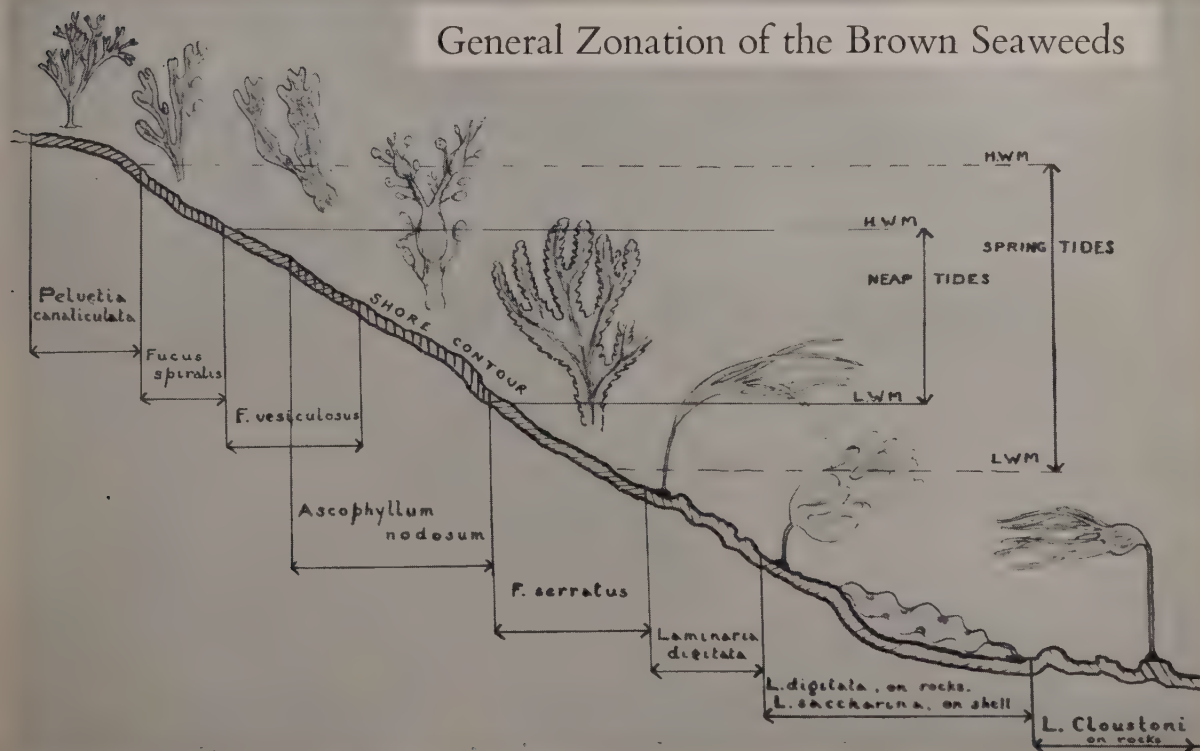
Seaweeds, or marine algae, to give them their proper name, are usually classified by colour—red, brown, blue and green—depending upon the nature of the pigment they contain. They are true plants dependent upon sunlight, carbon dioxide and the fertilizing minerals, potash and phosphate, for their healthy growth. Unlike land plants, they have no roots but absorb their nourishment through their fronds or leaves; they nearly always grow attached to rock and usually a certain amount of buffeting by wave action is beneficial.

A good idea of the zonation of the common

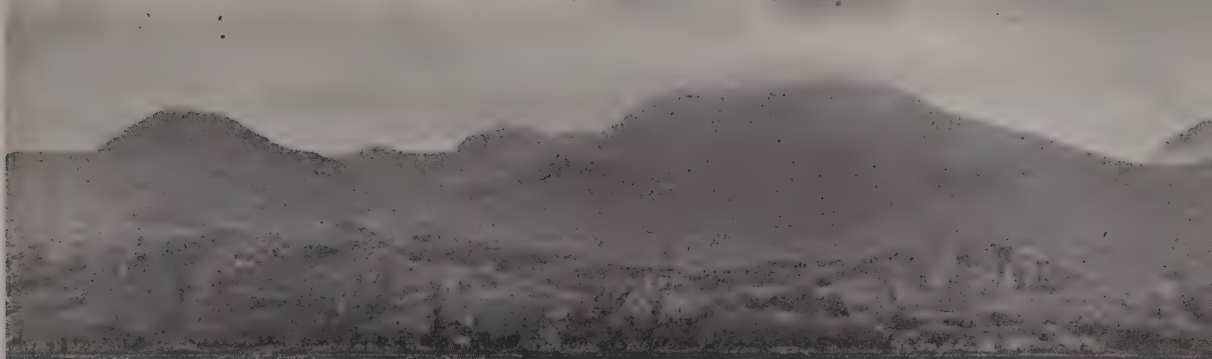
seaweeds can be obtained by walking along almost any rocky shore in Britain at low water away from built-up areas whose sewage spells death to the marine plant-life. The little rock-pools left by the receding tide will frequently be seen to contain small red and green seaweeds, the latter being particularly noticeable in the spring. Prominent amongst the red seaweeds is *Gigartina stellata* from which agar is obtained. Between high and low water marks are usually found five different types of brown 'littoral' seaweed, ranging from the small clusters of *Pelvetia canaliculata* in the splash zone, through the larger *Fucus spiralis* and the bladder wracks, *F. vesiculosus* and *Ascophyllum nodosum*, down to the serrated wrack, *F. serratus*, which is barely uncovered at low tide.

If we could walk into the sea where it has a rocky bed we should almost certainly find three distinct types of 'sub-littoral' seaweed of the species *Laminariaceae*, which are much bigger and quite unlike the littoral weeds seen on the shore as they have a smooth stalk or stipe which sometimes is several feet in length, surmounted by a large leaf or frond. The first type we should encounter would be the 'horsetail' kelp, *L. digitata*; lower down *L. saccharina*, a sweet-tasting plant with a crinkled leaf; and finally the robust *L. cloustoni* with a rough sturdy stipe, which

General Zonation of the Brown Seaweeds







Robert M. Ad

(Opposite) *Different kinds of seaweed grow at different levels. Top : Pelvetia canaliculata and Fucus vesiculosus. Middle : F. serratus. Bottom : Laminaria digitata and L. saccharina. (Above) Laminaria digitata exposed at a very low tide, on Loch Nan Uamh in Inverness-shire*

flourishes between five and seven fathoms. Beyond this seaweed growth diminishes rapidly as sunlight fails to penetrate.

Different localities and environments favour the growth of different species of plant in the sea as on the land, but the pattern just described is fairly generally found along the coastline of North-Western Europe, the Canadian Maritime Provinces, Newfoundland, the New England coast of North America and Japan.

The coastal waters of California and those off Southern Peru, Chile, Southern Argentina,

the Falkland Islands, New Zealand and Tristan da Cunha, on the other hand, are the home of the famous buoyant 'giant kelp' *Macrocystis pyrifera* which is the largest plant in the world, exceeding in height even the redwood trees of California.

SURVEYING THE SEAWEED BEDS

Until recently few serious attempts had been made to survey even the most prolific seaweed-bearing areas of the world; partly owing to lack of interest and partly on account of the difficulty of assessing accurately the

non-buoyant types which are usually invisible from the surface of the sea or from the air.

In Scotland, where most of Britain's seaweed grows, the Scottish Seaweed Research Association has been making an assessment of its algal resources. The problems to be solved before surveying could even be considered were many and difficult. Some idea of where the principal beds were located had first to be obtained. This was by no means easy, but an examination of Admiralty charts eliminated large areas of sand and mud on which seaweed could not grow. The next step was to find which beaches near the rocky areas had large amounts of the sub-littoral weeds thrown up on them by the winter storms. This necessitated weekly observations during two winters of over thirty beaches mostly in the remoter parts of Orkney, the Outer and Inner Hebrides, and the Scottish west coast. As a result it was found that the inshore waters of the Orkney group of islands and South Uist in the Outer Hebrides probably supported a bigger growth of the Laminariaceae than any other area off the coast of Britain, and the first serious attempt to determine the exact quantities and types of submerged seaweed was consequently centred on Kirkwall, the capital of the Orkney Islands.

The limits of the submerged seaweed beds in this area were first roughly pencilled on maps by two scientists in 1946, whilst scanning the Orkney seas from a low-flying slow-speed aeroplane, and the laborious task of estimating tonnages and types of seaweed in one of

the beds thus located was begun. A survey boat with a trained crew and botanist aboard examined the submerged seaweed in the manner shown opposite. After examining the seaweed at a depth of one fathom, the boat moved out at right angles to the shore until the two-fathom point was reached and the procedure was repeated; and so on at fathom intervals of depth until the weed petered out, usually at six to seven fathoms.

The boat then moved on 200 yards parallel to the coast and the procedure was repeated along a line parallel to the first. By this means the bed was covered and the resulting data, when plotted on a map and analysed by statisticians, enabled an accurate estimate to be made of the amount and type of weed growing in the area surveyed.

This work was carried out in Orkney for over two years, during which time the grab was lowered and raised and its contents weighed and analysed over 20,000 times. Slowly the picture unfolded and when the task was completed it was found that there were 60,000 acres of sea-bed between low water and six fathoms in the Orkney group of islands supporting 1,250,000 tons of useful seaweed.

Whilst this work was going on in Orkney, efforts were being made in collaboration with the R.A.F. to develop an easier method of survey based on aerial photography. War-time work had resulted in improved photographic techniques whereby the sea-bed could be photographed in detail from fast-

moving planes and, after considerable experiment, it was found that these techniques could be modified to record photographically in some detail the submerged seaweed beds growing in Scottish inshore waters. This was a tremendous step forward and eventually saved years of laborious and expensive boat work, for as soon as the coastal areas of Scotland had been photographed using this technique, most of the initial work could be carried out in an office with relatively few random boat-samplings to provide the quantitative data.

Although the survey of the Scottish seaweed beds is not yet complete, sufficient has been done to indicate that the



A survey boat, with a trained crew and a botanist on board, was used to discover the type and quantity of seaweed in one of the beds previously located by observation from the air. (Right) The plants were more thoroughly examined through a view-box, a piece of apparatus rather like a telescope dipping into the water. Having satisfied themselves that the bed contained sufficient seaweed of the right type for ultimate harvesting and having defined the limits of the bed in more detail, the surveyors took up a station over the bed where the water was one fathom deep



The Scottish Field



(Left) When the boat had moved to this position, a specially designed spring-grab was let over the side. As soon as it touched the sea-bed it closed, and collected all the seaweed growing on half a square yard. This was hauled into the boat and the contents weighed and divided into the various types before moving to deeper water

4500 miles of Scottish coastal waters contain total seaweed resources of about 10,000,000 tons, equivalent to a potential annual harvest of about 1,000,000 tons of wet seaweed. Although no surveys as accurate as this have been made elsewhere, such areas as have been examined along the coastlines of Norway, western Canada and United States, and the Falkland Islands have been found to support at least a further 60,000,000 tons of seaweed.

THE USES OF SEAWEED CHEMICALS

Brown seaweed was used almost continuously from about 1720 until the end of the 19th century in Norway, Brittany, Scotland and Ireland, both as a fertilizer and as a raw material for the chemical industry. It is still used as a fertilizer in coastal areas in these countries as, although it is deficient in phosphate and nitrate, it is an excellent manure for potatoes. The North-West European chemical industry, based on burnt seaweed or kelp as it was called, virtually died at the turn of the century, however, as the soda, potash and iodine produced from it up to that time failed to compete with similar material obtained more cheaply from the mineral deposits discovered later in Central Europe and Chile. Before the industry died, however, E. C. C. Stanford, a chemist associated with the old iodine-from-seaweed industry in Scotland, foreseeing the end of the industry, looked at that part of the seaweed which had been burnt for nearly 200 years in the Outer Hebrides, in the hope that he would find one or more chemicals there of potential value to industry. In this he was successful for, as a result of his search, he discovered the alginic acid which was subsequently used in the wartime camouflage material.

As very frequently happens, however, Stanford lived before his time and the 19th-century industrialists failed to make use of his discovery, which lay hidden in an obscure chemical journal until C. W. Bonniksen rediscovered it fifty years later.

In recent years chemists have been making detailed studies of the composition of these marine plants and it has been found that they resemble land crops such as cereals, maize, rice and timber in that they are made up primarily of carbohydrates, proteins and minerals with the appropriate pigments, vitamins and sterols present in smaller amounts necessary for the healthy growth of any complex living organism.

The difference between land and sea plants lies in the varying composition of the individual constituents. The former, in general, owe their strength and rigidity to the presence

of a high proportion of cellulose in their make-up; in the brown seaweeds this function is taken over by a unique chemical of similar but not identical constitution—*alginic acid*. The reserve food of land plants is starch, that of marine plants a similar compound named *laminarin*, whilst the place of sugar in the former is taken by *mannitol* in the latter. The first two of these seaweed chemicals are unique as they are found nowhere else in the world; the third, mannitol, on the other hand can be manufactured from cane sugar by means of a complex chemical reaction but is not generally available outside America. In other words, there could be made available each year, as soon as economic seaweed-harvesters have been devised and brought into operation, millions of tons of these new chemicals: Scotland alone is capable of providing each year a combined total of 100,000 tons.

Largely as the outcome of the British wartime use of alginic acid, the remarkable properties of this chemical have become better understood and, in consequence, it now has an assured place in the world chemical market. Something like 200,000 tons of seaweed are annually converted into alginates in Britain, America, Norway and France and the chemical finds outlets in a wide range of commodities, varying from sauce and soup thickeners and ice-cream stabilizers to the manufacture of moulding compositions for taking dental impressions.

Perhaps the most spectacular use of this seaweed chemical is in the production of soluble alginate yarns which are used as scaffolding in the manufacture of ultra-light-weight wool fabrics. Having served as a strengthener of the fine woollen yarns during the weaving process it is dissolved out and the remaining fabric, although as light as silk, has all the warmth and pleasant feel of a woollen fabric.

Less spectacular but more important still are the uses now being developed for alginates in surgery and medical practice. It has been found that alginates are ideal carriers of penicillin and bone-healing hormones and, being readily absorbed and haemostatic, they can be used as soluble ligatures and to plug internal lesions to prevent bleeding: having achieved its purpose the alginate plug or ligature, being soluble, dissolves with the wound. Burns may also be treated by covering with a film of alginate, the protective film subsequently being removed without discomfort.

Of the remaining chemicals found in the brown seaweeds only one, the sugar-like



Douglas P. Wilson

Keystone Press

How few people, when they are enjoying an ice-cream at the seaside, realize that a most important source of one of the ingredients in its manufacture may be the brown seaweed along the shore

mannitol, has so far found industrial application. It is employed in the manufacture of detonators, fancy papers and certain pharmaceuticals and in the production of synthetic resins. The true value of this chemical will only appear as the results of investigations now being carried out in a number of British and American universities and industrial laboratories become available. The remaining seaweed chemicals are so new that it is impossible to forecast the uses which may be found for them, although there are already indications that laminarin can be used as a substitute for blood plasma and as a source of the energizing sugar, glucose.

Less is known about the chemistry of the red seaweeds, which are unlike the more abundant brown algae in appearance, habitat and constitution. So far as is known they do not contain any of the chemicals found in the brown weeds although they do contain certain starch-like compounds which have already found many useful outlets in indus-

try; principal amongst these is agar.

This material, which is famous for its jelly-like properties, was made and used in great quantities in Japan prior to the war. Its chief, although perhaps little known, use is as a testing medium in the production of antibiotic drugs. When penicillin production was increased during the war, agar was required in considerable quantities to check the process step by step and as Japanese supplies were no longer available, many Allied countries produced their agar requirements from red weed grown on their own shores. In this way during the course of a very few months Great Britain, America, Australia, New Zealand and South Africa all accumulated the necessary reserve of this material, and the agar industries in these countries have been maintained since the war. Although not used as widely as its brown seaweed counterpart, alginic acid, agar is used in a wide variety of ways. In addition to being a mild laxative it is used in the confectionery, bakery and



The Scottish Field

Much seaweed is harvested by hand. The simplest mechanical method is a grapnel, fitted to a small boat, which when dragged along the sea-bed can gather up to five hundredweight at a time

cosmetic trades and to an increasing extent by meat-packers.

METHODS OF HARVESTING

Before much more can be done on the industrial scale it is obvious that uses must be found for these chemicals. Like many new industries built up on a raw material about which little is known, the seaweed industry can only succeed if a method of harvesting is developed capable of maintaining a steady supply of the material to industry at an economical price.

The old kelp industry was based almost entirely upon seaweed thrown up on the shores after the winter storms and its collection by hand was, at best, a hazardous and unpleasant occupation. This method is still employed in Ireland, Norway, the Scottish Outer Hebrides and in Brittany although it is now generally realized that if the industry is to reach sizeable proportions mechanical methods of harvesting must be developed. Considerable progress has already been made in this direction by the engineers of the Scottish Seaweed Research Association, and the day is probably not far off when seaweed-collecting boats become as common a sight as the fishing boats operating along our coasts.

The problems which have had to be solved are amongst the most difficult that marine engineers have yet faced as the underwater

algae, besides being invisible from a boat and heavier than water, must have rock on which to grow and will only do so in relatively shallow water. Even on calm days in North Britain the swell in shallow coastal waters is appreciable, a fact which makes matters no easier.

Despite these difficulties, two methods of harvesting have been worked out, both of which have proved effective. The first and easiest consists of towing a specially designed grapnel along the sea-bed behind a small fishing boat, the most recent types being capable of bringing up a quarter of a ton of seaweed per drag. The second method is more highly mechanized and capable of landing larger catches. It is based upon the principle of the common dredge with the dredge-buckets replaced by rows of hooks which, having torn the weed off the rocks on the sea-bed, throw it into the hold of the harvesting vessel.

A third method, which is undergoing trial and perhaps shows even greater promise, consists in dragging what is essentially a combined lawn-mower and vacuum-cleaner over the sea-bed from the stern of the harvesting vessel. These last two methods between them may have solved the problem of supplying living brown seaweed at an economic price and in a constant quantity and quality to the small but rapidly growing industry.